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INTRA-ABDOMINAL COMPLICATIONS FOLLOWING DISTAL SUBTOTAL GASTRECTOMY FOR BENIGN GASTRODUODENAL ULCERATION

CHARLES W. PEARCE, M.D., GEORGE L. JORDAN, JR., M.D., AND MICHAEL E. DEBAKEY, M.D., HOUSTON, TEX.

(From the Cora and Webb Mading Department of Surgery, Baylor University College of Medicine, and the Surgical Service of the Veterans Administration Hospital)

DISTAL subtotal gastrectomy is the operation most often employed for the surgical treatment of benign gastroduodenal ulceration. This procedure may be followed by many complications that may occur after any operation, but approximately one-half of the reported morbidity and mortality rates has been attributed to intra-abdominal complications. Many of these, such as leakage from the duodenal stump and postoperative gastric retention, are unique to this procedure. This study was undertaken to review the problems presented by such complications and to report the experience at the Veterans Administration Hospital, Houston, Texas.

CLINICAL MATERIAL

From 1949 through 1955, 406 gastric resections were performed on 403 patients. Three hundred twenty-four were for duodenal ulcer, 63 for gastric ulcer, and 19 for marginal ulcer. The youngest patient was 22 years old and the oldest 79. All but one were men. Emergency operations were performed for massive hemorrhage in 13 per cent and for acute perforation in 15 per cent. In the remainder elective gastrectomies were performed, though in some with complete obstruction or the likelihood of recurrent massive hemorrhage the procedure might be considered a relative emergency.

Two-thirds to four-fifths of the stomach was removed except in cases of marginal ulcer that developed after previous partial gastrectomy. In these patients, approximately 10 to 15 per cent of the stomach was left. Prior to 1953, gastrointestinal continuity was re-established by gastrojejunostomy in

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nearly all patients. However, because of increased interest in the procedure during the last 3 years of this study, gastroduodenostomy was used in approximately 30 per cent of the patients. Of those patients treated with gastrojejunostomy, the Hofmeister modification was used in over 80 per cent, and the anastomosis was placed in the antecolic position in 70 per cent. The area of ulceration was excised in all patients with gastric and marginal ulcers and in 223 of the patients with duodenal ulcers. In 67 patients it was left intact or only partially excised, and in 34 the data were insufficient to ascertain this accurately. In 400 (98.5 per cent), the usual gastrectomy was performed, and in the remaining 6, an alternate procedure was used: catheter duodenostomy in one, 2-stage gastrectomy in one, and transection proximal to pylorus with excision of remaining gastric mucosa in 4. In 3 additional patients, a T tube was inserted into the common bile duct as an aid in identification.

MORTALITY

All patients who died within one month postoperatively were listed as operative deaths. Two other patients who survived longer were included in this classification because postoperative complications were significant contributory factors in their deaths. There were 11 deaths in the entire series, a case fatality rate of 2.7 per cent. Ten of these occurred in patients with duodenal ulcers, giving a case fatality rate of 3.1 per cent for this lesion, whereas no deaths occurred in the patients with gastric ulcers.

All the deaths occurred in patients treated for massive hemorrhage. Ten had undergone emergency operations, and the eleventh was a 78-year-old man whose operation was of an emergency nature because of the threat of repeated massive hemorrhage. Thus, there were no fatalities in patients treated for perforation, obstruction, or intractability, and the case fatality rate for nonemergency operations was 0.3 per cent.

TABLE I. CAUSE OF DEATH FOLLOWING SUBTOTAL GASTRECTOMY

CAUSE OF DEATH	NUMBER OF CASES
Congestive heart failure	2
Aspiration pneumonia	2
Septicemia	2
Myocardial infarction	1
Cardiac arrest	1
Renal failure	1
Hepatic failure	1
Gastroduodenal anastomotic leak	1
Total	11

Four deaths were cardiac in origin and only one was the direct result of an intra-abdominal complication, peritonitis from a leaking gastroduodenal anastomosis (Table I). However, in 2 other patients, intra-abdominal complications contributed to the fatal outcome. In one of these, severe postoperative gastrointestinal hemorrhage was probably a major factor in the development of renal failure. The other patient was transferred to this hospital with serum hepatitis following multiple operative procedures, including

closure of a perforated ulcer, lysis of adhesions, and drainage of multiple intra-abdominal abscesses. One week later, massive hemorrhage developed; replacement of blood was continued for 24 hours, when surgical intervention became mandatory. On the third postoperative day, separation of the abdominal wound, the duodenal stump closure, and the gastrojejunostomy occurred. Adequate nutrition was impossible because of leakage from the gastrojejunostomy. The patient remained jaundiced and died of hepatic failure on the forty-third postoperative day. Hepatic disease and other systemic factors contributed to the intra-abdominal complications, which, in turn, made proper therapy of the hepatitis impossible and thus contributed to the fatal outcome.

Therefore, since intra-abdominal complications were directly responsible for one death and contributory causes for 2 others, 27.3 per cent of the fatalities occurred in patients with such complications (0.7 per cent of the entire series).

INTRA-ABDOMINAL COMPLICATIONS

Sixty intra-abdominal complications, an incidence of 14.8 per cent, occurred in 53 patients, 13.1 per cent (Table II).

TABLE II. INTRA-ABDOMINAL COMPLICATIONS FOLLOWING 406 SUBTOTAL GASTRECTOMIES FOR PEPTIC ULCER

COMPLICATIONS	DUODENAL ULCER (324 CASES)		GASTRIC ULCER (63 CASES)	MARGINAL ULCER (19 CASES)	TOTAL (406 CASES)	
	NO. CASES	NO. DEATHS			NO. CASES	NO. DEATHS
Gastrointestinal bleeding	12	1	1	1	14	1
Leakage, duodenal stump	10		0	0	10	
Gastric retention	6		0	1	7	
Subphrenic abscess	6		0	0	6	
Intestinal obstruction	4		0	0	4	
Intra-abdominal bleeding	3		0	0	3	
Leakage, gastroduodenostomy	2	1	0	0	2	1
Laceration of spleen	2		0	0	2	
Adynamic ileus, severe	1		0	1	2	
Peritonitis	1		1	0	2	
Pancreatic fistula	1		0	0	1	
Pelvic cellulitis	1		0	0	1	
Leakage, gastrojejunostomy	1	1	0	0	1	1
Injury to common bile duct	1		0	0	1	
Pancreatitis	1		0	0	1	
External fistula, small intestine	1		0	0	1	
Esophagitis with stricture	0		0	1	1	
Jaundice, transient	1		0	0	1	
Total	54	3	2	4	60	3

Gastrointestinal Bleeding (Table III).—Hemorrhage into the gastrointestinal tract developed during the early postoperative period in 3.4 per cent of patients. In 5, shock did not develop and no more than 1,000 c.c. of blood were required in any 24-hour period, whereas in 9 shock developed. In 6, the bleeding began during the first 24 hours postoperatively and, in the remainder, from the third to the fifteenth postoperative day. There was no significant difference in the incidence of bleeding following different types of operative

TABLE III. POSTOPERATIVE GASTROINTESTINAL BLEEDING FOLLOWING 406 SUBTOTAL GASTRECTOMIES FOR PEPTIC ULCER

PT. NO.	DIAGNOSIS	POSTOP. DAY OF ONSET	DEGREE OF BLEEDING	MANAGEMENT	ULCER REMOVED	CAUSE OF BLEEDING	PREVIOUS BLEEDING
1	Duodenal ulcer	5	Mild	Conservative	Yes	Probably technical error	Remote, melena
2	Duodenal ulcer	Day of operation	Severe	Operative	Yes	Technical error	Acute, massive
3	Duodenal ulcer	10	Severe	Conservative	Yes	Probably technical error	Recent, hematemesis
4	Duodenal ulcer	6	Severe	Operative	Yes	Bleeding diathesis	Recent, hematemesis
5	Duodenal ulcer	Day of operation	Mild	Conservative	Yes	Probably technical error	None
6	Duodenal ulcer	13	Severe	Operative	No	Bleeding diathesis	Recent, hematemesis
7	Duodenal ulcer	6	Severe	Conservative	No	Probably technical error	Acute, massive
8	Duodenal ulcer	9	Severe	Conservative	Yes	Probably technical error	Acute, massive
9	Duodenal ulcer	15	Mild	Conservative	Yes	Cortisone therapy	Acute, massive
10	Duodenal ulcer	Day of operation	Severe	Operative	No	Technical error	Remote, melena
11	Duodenal ulcer	Day of operation	Severe	Conservative	Yes	Probably technical error	Remote, hematemesis
12	Duodenal ulcer	3	Severe	Conservative	Yes	Bleeding diathesis	Acute, massive
13	Gastric ulcer	Day of operation	Mild	Conservative	Yes	Probably technical error	None
14	Marginal ulcer	Day of operation	Mild	Conservative	Yes	Probably technical error	Recent, hematemesis

procedures. The one death (Patient No. 7) occurred in the patient in whom renal failure developed. Autopsy revealed hemorrhagic mucosa at the anastomotic line but no evidence of bleeding from the ulcer bed.

In one patient (No. 12) a plasma thromboplastin antecedent deficiency became evident postoperatively which had not been detected preoperatively despite hematologic studies. Bleeding occurred on the fifteenth postoperative day in one patient (No. 9) who had received cortisone therapy before operation and had been maintained on it postoperatively. Bleeding ceased after cortisone was discontinued. In a third patient (No. 6), bleeding occurred in the presence of acute renal failure with extreme azotemia, and in a fourth patient (No. 4) severe hypoprothrombinemia developed during administration of broad spectrum antibiotic drugs. At reoperation multiple bleeding points in the gastric and jejunal mucosa were noted. Another operation was necessary in 2 additional patients, both of whom were bleeding from the anastomotic line or lesser curvature as a result of technical errors. In the remaining patients, the site of bleeding was not ascertained, but it is reasonable to assume

that bleeding arose from the anastomotic line or the lesser curvature. In none of these was a hemorrhagic diathesis present, and the ulcer had been excised in all but one. In this patient (No. 10) a scarred ulcer bed was left but no bleeding had occurred for several months prior to operation.

Thus, in 4 patients (29 per cent) postoperative bleeding was attributed to systemic factors, whereas in the remaining 10 (71 per cent) no such cause could be ascertained, and bleeding was probably due to technical errors. Twelve of the 14 patients had bled prior to gastrectomy; 5 had massive bleeding at the time of gastrectomy, 4 at the time of admission, and 3 within the previous 12 months.

Comment: Immediate postoperative gastrointestinal bleeding must be ascribed to a technical error until proved otherwise. If the lesser curvature is closed, this may be the site of hemorrhage, as large branches from the left gastric vessel frequently take an intramural course along the lesser curvature and special care must be taken to obtain accurate ligature. If occluding clamps are used while anastomosis is being accomplished, they should be released before the anastomosis is completed so that inspection for bleeding may be carried out.

In our experience, patients who have bled from peptic ulceration are most likely to bleed postoperatively and should receive particular care in hemostasis. It is possible that some patients have a bleeding tendency that cannot be detected by the usual methods.

An additional cause for postoperative bleeding is rapid development of marginal ulcer. Recently, in one patient (not included in this study) massive hemorrhage developed from a marginal ulcer, requiring reoperation on the eleventh postoperative day. If bleeding occurs 3 to 4 weeks postoperatively, marginal ulcer is the most likely reason. In this study we encountered 3 patients in whom massive bleeding developed from marginal ulcers within one month of operation.

Leakage of Duodenal Stump (Table IV).—Leakage from the duodenal stump occurred in 3.4 per cent of patients in whom gastrointestinal continuity had been re-established by gastrojejunostomy. All had been treated for duodenal ulcer.

Evidence of leakage through the stump appeared from the third to tenth day (average of 5.9 days). In the 9 surviving patients, fistulas persisted from 12 days to one year, with an average of 27 days, excluding the patient who had slight drainage for one year. Operative closure was necessary in only this one instance.

In 8 of the 10 patients, closure was considered difficult or insecure. Adverse systemic factors were present in 6 patients, though all but one of these were associated with difficult or insecure closure of the duodenal stump. In 3 instances, the stump was closed proximal to areas of duodenal stenosis. In no patient was obstruction of the afferent loop or stroma apparent.

In 2 instances the ulcer was perforated while an adherent gall bladder was being dissected. In both, the perforation was closed and a modified Bancroft mucosal excision was carried out. It is not possible to say whether the leak

TABLE IV. DUODENAL STUMP AND GASTRODUODENOSTOMY LEAKAGE FOLLOWING SUBTOTAL GASTRECTOMY FOR PEPTIC ULCER

PATIENT	MANAGEMENT	TYPE OF RESECTION	ASSOCIATED FACTORS	DRAINAGE AT TIME OF GASTRECTOMY	POSTOP. DAY LEAKAGE MANIFEST	DELAY IN DIAG. OF LEAKAGE	MANAGEMENT	DURATION OF FISTULA (DAYS)
1	Excised	Gastrojejunostomy	Closure difficult, hypoproteinemia	Yes	3	None	Conservative	Died
2	Excluded	Gastrojejunostomy	Closure difficult	No	4	48 hours	Operative drainage	24
3	Transected	Gastrojejunostomy	Closure difficult, malnutrition	Yes	10	None	Operative drainage	21
4	Excised	Gastrojejunostomy	Closure difficult, anemia, malnutrition	Yes	4	None	Conservative, surgical closure—1 year postop.	1 year
5	Excluded	Gastrojejunostomy	*Closure difficult, stenosis of duodenum distally	No	5	None	Operative drainage	15
6	Excised	Gastrojejunostomy	Malnutrition	Yes	9	48 hours	Operative drainage	28
7	Transected	Gastrojejunostomy	Closure difficult, malnutrition	Yes	8	None	Conservative	12
8	Excluded	Gastrojejunostomy	*Closure difficult	Yes	4	None	Conservative	60
9	Excluded	Gastrojejunostomy	*Closure difficult, stenosis of duodenum distally, malnutrition	Yes	4	None	Conservative	31
10	Excluded	Gastrojejunostomy	Stenosis of duodenum distally, but no preop. obstruction	Yes	8	None	Conservative	25
11	Excised	Gastroduodenostomy	**Dissection difficult, deeply penetrating ulcer, anemia, poorly nourished	Yes	9	None	Conservative	Died
12	Excised	Gastroduodenostomy	Severe scarring and edema	No	3	None	Operative drainage	30

*Modified Bancroft mucosal excision procedure.
**Choledochotomy and insertion of T tube.

occurred from closure of the pyloric stump or from the site of perforation. However, these cases have been included in this tabulation. In one other patient who had the mucosal excision procedure, leakage also developed with formation of fistula. Therefore, in this series, the Bancroft procedure was associated with fistula formation in 3 of the 4 patients thus treated.

Eight patients had primary drainage. In 6 of these a fistula developed without significant intra-abdominal inflammation, whereas the other 2 required reoperation to establish better drainage. Both patients in whom drainage was not instituted at the time of gastrectomy required reoperation. In 8 of the 10 patients the diagnosis was established within 24 hours of the onset of symptoms. The only death in this group (10 per cent) occurred in the patient with hepatic failure.

Comment: The incidence of leakage of the duodenal stump reported in the literature varies from 0.0 to 3.7 per cent.[3, 18] Undoubtedly, the choice of patient in whom gastrectomy is performed influences this considerably, for if an alternative procedure, such as vagotomy and gastroenterostomy, is used in some, the incidence of this complication should be low. In this institution all patients who undergo a definitive surgical procedure for duodenal ulcer are treated by subtotal gastrectomy. Vagotomy or gastroenterostomy and vagotomy have never been used as the primary surgical treatment, although vagotomy alone is occasionally performed for marginal ulcer. During the entire 7 years of this study, only one patient with duodenal ulcer was treated by a surgical procedure other than subtotal gastrectomy. This patient, an extremely poor surgical risk, had gastroenterostomy. Consequently, the incidence of resection for duodenal ulcer was 99.8 per cent, and all but 2 patients (one with catheter duodenostomy and one with 2-stage gastrectomy) had primary closure of the duodenal or pyloric stump.

Factors influencing leakage from the stump may be divided into (1) systemic, interfering with proper healing, (2) obstructive, producing back pressure, (3) devitalization of the region of the closure, and (4) local, making closure technically difficult. The most significant, in our experience, as well as that of others, are the local factors. Actual devitalization of the stump by extensive dissection seems to be largely a theoretic consideration. However, leakage of pancreatic enzymes may well be a contributant after excision of deeply penetrating posterior ulcers. In the experience of Avola and Ellis,[1] obstructive factors were responsible for 4 of 13 cases of leakage of the stump. In 3 of our cases, the stump was closed proximal to stenosis in the duodenum, although in none was obstruction of the afferent loop or stoma apparent.

If closure of the stump appears secure, we prefer to close the abdomen without drainage. However, we have utilized drainage whenever systemic or local factors seemed to indicate that healing might be delayed. Although there is no general agreement concerning the value of drainage of the duodenal stump, we do not agree with Rienhoff[20] that drainage invites infection and increases the possibility of fistula formation. On the contrary, drainage allows prompt diagnosis and, in most cases, will obviate reoperation. Larsen

and Foreman[10] considered delay in diagnosis a significant factor in the high case fatality rate (75 to 85 per cent) frequently reported in the literature. Early diagnosis and treatment were instituted in 8 of our 10 patients, and the one death was not due directly to leakage of the stump, but rather to other factors. Consequently, although procedures such as catheter duodenostomy and 2-stage gastrectomy are valuable adjuncts in management of the duodenal stump, we believe their use is rarely indicated. Catheter duodenostomy may be associated with complications such as persistent fistula, leakage around the catheter, and fluid and electrolyte depletion. Moreover, marginal ulceration has been reported by Robertson,[21] who attributed this to the unopposed gastric secretions, while bile and pancreatic juices drained through the catheter. A 2-stage gastrectomy subjects the patient to 2 major operations, and should he refuse the second procedure, he is likely to be left with an inadequate operation. Therefore, unless the patient's general condition is such that the operation must be completed as rapidly as possible, we believe that dissection and closure of the duodenal stump can almost always be accomplished. In our experience, spontaneous development of a duodenal fistula has not been a great deal more serious than the fistula created purposely by catheter duodenostomy.

Fistulas are managed by sump suction, use of aluminum paste to protect the skin, careful maintenance of fluid and electrolyte balance, and administration of blood, when indicated, to aid maintenance of nutrition and hasten closure of the fistula. The patient is encouraged to eat as soon as oral intake of food is tolerated. Whereas this stimulates secretion of bile and pancreatic juices, adequate intake of fat and protein can be obtained only by the oral route and the advantages of an adequate diet far outweigh these objections.

Leakage of Gastroduodenostomy or Gastrojejunostomy.—Leakage from the gastrojejunostomy occurred in only one instance; the patient mentioned previously had hepatitis simultaneously with dehiscence of the duodenal stump and abdominal wall. Leakage in this instance was ascribed to systemic factors.

Leakage from the gastroduodenostomy occurred in 2 (1.8 per cent) of the patients who had gastrointestinal continuity re-established by gastroduodenostomy. In one of these generalized peritonitis developed, followed by death, whereas in the other the leak was small and closed spontaneously.

Comment: In our opinion, leakage from gastroduodenostomy is a much more serious complication than a "blown" duodenal stump, for these circumstances pose the same problem as that encountered in a lateral duodenal fistula. Oral ingestion of liquids and food serves only to accentuate the drainage. It is sometimes possible to pass a small mercury-weighted polyethylene tube through the gastroduodenal stoma so that feeding of a liquid formula into the small intestine can be instituted.

Review of these cases, as well as others in this locality in which the same complication developed, reveals that a high percentage of them occurred when

it was necessary to dissect a large posterior penetrating ulcer from the pancreas. Under these circumstances, the suture line is placed against a raw pancreatic bed from which leakage of pancreatic enzymes frequently ensues. This represents a definite etiologic factor in the development of this complication. Consequently, the presence of a large posterior penetrating ulcer, requiring extensive dissection of the pancreas, is now considered a definite contraindication to use of the Billroth I procedure.

Gastric Retention (Table V).—This complication developed in only 1.7 per cent of all cases. Since no patient with a gastroduodenostomy had this difficulty, the incidence of patients who had gastrojejunostomy was 2.4 per cent. Symptoms appeared as early as the second day and as late as the twelfth. In all 5 patients treated conservatively, a good response was obtained. Two, however, required reoperation. In one, sutures in the mesocolon had pulled apart; this permitted retraction of the gastric remnant and kinking of the efferent loop. In the other, pancreatitis had produced adhesions of the transverse mesocolon and omentum, causing obstruction of the efferent loop.

Although the jejunal loops were placed in the antecolic position in 70 per cent of all patients in whom the Billroth II procedure had been used, retrocolic anastomosis was employed in 5 of the 7 patients in whom gastric retention developed. In 6 patients the anastomosis was placed in an isoperistaltic position, afferent loop to lesser curvature, although this arrangement was used most commonly in the entire series.

Comment: Gastric retention is commonly attributed to stomal obstruction, and some of the early investigations indicated that malnutrition or fluid and electrolyte imbalance played important etiologic roles, giving rise to edema at the suture line. Only one of our patients had malnutrition or hypoproteinemia, neither severe.

Absence of bile in the vomitus or aspirated fluid points to obstruction of the afferent loop or stoma. Partial obstruction of the stoma might allow some bile to enter the gastric pouch; however, if bile is present in the gastric aspiration, obstruction of the efferent loop is likely. Such was the case in both patients in whom reoperation confirmed the diagnosis.

Gastric atony has also been incriminated as an etiologic factor, but in this institution studies of gastric motility (in the early postoperative period) substantiate the conclusion of Golden[6] that gastric peristalsis plays little part in emptying of the gastric remnant after subtotal gastrectomy.

On the basis of roentgenographic studies, Golden attributed obstruction of the efferent loop to spasm "due to a localized temporary disturbance in muscle function resulting from the necessary surgical trauma to the jejunum in making the anastomosis." Roentgenograms made on our 2 patients who underwent re-exploration revealed findings similar to those described by Golden, but the pathologic entity was that of true mechanical obstruction, and we are of the opinion that mechanical obstruction of the efferent loop probably accounts for most cases of stomal obstruction. Few reports in the literature of patients with this syndrome contain roentgenographic studies so that the site

TABLE V. GASTRIC RETENTION FOLLOWING 406 SUBTOTAL GASTRECTOMIES FOR PEPTIC ULCER*

PATIENT NO.	DIAGNOSIS	TYPE OF ANASTOMOSIS	POSTOP. DAY OF ONSET	DURATION (DAYS)	SITE OF OBSTRUCTION	ROENTGENOGRAPHIC EXAMINATION	MANAGEMENT
1	Duodenal ulcer	Gastrojejunostomy, antecolic, isoperistaltic	7	12	Undetermined	None	Conservative
2	Duodenal ulcer	Gastrojejunostomy, retrocolic, isoperistaltic	10	4	Efferent loop	Obstruction efferent loop	Conservative
3	Duodenal ulcer	Gastrojejunostomy, retrocolic, isoperistaltic	11	3	Undetermined	None	Conservative
4	Duodenal ulcer	Gastrojejunostomy, retrocolic, isoperistaltic	4	14	Efferent loop	Obstruction efferent loop	Enteroenterostomy
5	Duodenal ulcer	Gastrojejunostomy, retrocolic, antiperistaltic	2	27	Efferent loop	Obstruction efferent loop	Takedown retrocolic anastomosis; anterior gastrojejunostomy
6	Duodenal ulcer	Gastrojejunostomy, antecolic, isoperistaltic	7	13	Undetermined	None	Conservative
7	Marginal ulcer	Gastrojejunostomy, retrocolic, isoperistaltic	5	7	Undetermined	None	Conservative

*All patients had 2-layer anastomosis. None had vagotomy. All recovered. One patient had slightly low serum proteins. There were no apparent electrolyte imbalances although determinations were not done in all patients. All had bile-stained drainage during period of retention.

of obstruction could be ascertained. If this were done routinely, we believe that the concept of obstruction at the suture line would assume less importance.

Injury to Pancreas and Biliary Tree.—There was one patient with clinical evidence of acute pancreatitis in this series and one in which a pancreatic fistula developed following dissection of a deeply penetrating duodenal ulcer. Injury to the common bile duct occurred in only one patient, who required 2 additional operative procedures for control of the resultant external biliary fistula. One additional patient had transient jaundice in the postoperative period; this may not have been associated with an intra-abdominal complication, but the exact etiology was not ascertained. There were no deaths.

Comment: Formation of a pancreatic fistula may develop simply from a deeply penetrating ulcer, but actual penetration of the ulcer into the duct of Santorini or, rarely, into the duct of Wirsung, or damage to these ducts at the time of operation must always be considered. Warren[27] pointed out that the duct of Santorini is the most vulnerable portion of the pancreas in gastric resection. This was confirmed in the anatomic studies of Millbourn,[15] who concluded that there is danger of injury to this duct in 50 per cent of cases and that such injury will have severe consequences in 10 per cent of these cases in which the duct functions as the sole or chief excretory channel of the pancreas. He found a much higher incidence of pancreatitis than was observed in our series, but undoubtedly some degree of pancreatic injury occurs more commonly than is clinically recognized, as Mahaffey and Howard[12] reported a distinct rise in the serum amylase concentration in 7 of 20 patients studied.

There is no convincing evidence that results following excision of the duodenal ulcer are better than those obtained when the ulcer is left in situ as long as all gastric mucosa is excised. Therefore, the wisdom of extensive dissection of an ulcer bed is questionable except in patients in whom this maneuver is necessary to control severe hemorrhage. Under such circumstances, use of a T tube as an aid in identifying the common duct in relation to the duodenum, advocated by Lahey,[9] is valuable. This method permitted more rapid, safe dissection in the 3 instances in which it was used in this series.

Intestinal Obstruction.—Classical obstruction of the small intestine resulting from adhesions occurred in 4 patients (1.0 per cent). Two of these required reoperation for relief, whereas the other 2 responded to conservative management. Two additional patients experienced severe protracted paralytic ileus. There were no deaths.

Comment: Intestinal obstruction is a relatively rare complication following gastrectomy. It is usually due to adhesions, but in some instances it may be due directly to the operative procedure, resulting from herniation through the transverse mesocolon or herniation behind the loops of a gastrojejunostomy. Stammers,[25] who reviewed the latter complication in some detail, has advised suture closure of this opening, particularly in the relatively long loop antecolic

anastomosis. In most series, the complication has been so rare that this extra step has not appeared necessary. Although antecolic anastomoses were used primarily in this study, this type of obstruction was not observed.

Another type of obstruction peculiar to gastrectomy is obstruction of the afferent loop. As pointed out by Warren,[28] this should be suspected whenever the gastric aspiration or vomitus does not contain bile. Thal and Perry[26] called attention to the fact that this condition may cause a prominent rise in the serum amylase, and therefore simulate acute pancreatitis. Such an error in diagnosis may have fatal consequences.

Intra-Abdominal Infection.—Incision and drainage were followed by recovery in 2 patients with subphrenic abscess and in 3 treated conservatively. In the sixth, the patient who died of hepatitis, the diagnosis was made at autopsy. One case of generalized peritonitis due to intra-abdominal rupture of wound abscess was successfully treated by operative intervention. One additional case of mild generalized peritonitis occurred, the exact etiology of which was obscure, and in one instance pelvic cellulitus followed treatment of a perforated ulcer.

Comment: Prevention of intra-abdominal infection involves principles that need no elaboration here. However, delay in diagnosis and definitive treatment is often due to confusion with pulmonary disease. Awareness of the possibility of subphrenic abscess will often lead to the correct diagnosis.

Miscellaneous Complications.—Laceration of the spleen necessitating splenectomy occurred in 2 instances, in neither of which did it add to the morbidity of the postoperative course. In one patient, a small intestinal fistula developed after dehiscence of a wound and secondary closure; although its exact etiology was not proved, it was probably due to injury of the intestine during insertion of retention sutures. Esophagitis with stricture, requiring reoperation, was observed in one patient. Intra-abdominal bleeding developed in 3; one from granulations about a leaking duodenal stump necessitated reoperation. The cause of unexplained shock in 2 patients became evident by passage of clotted blood from the site of drainage on the second postoperative day.

Comment: Laceration of the spleen is an avoidable error due to improper use of retractors during the course of high subtotal resection. Whereas these 2 patients did not suffer from this mishap, the complications that may follow splenectomy are such that it should always be avoided. The possibility of intra-abdominal bleeding should be considered in any case of unexplained tachycardia or hypotension following gastrectomy. Despite the fact that primary drainage had been carried out in our patients, bloody fluid did not appear at the site of drainage until 24 hours after the onset of bleeding.

Several relatively rare complications have been reported in recent years. Of 16 cases of jejunogastric intussusception reviewed by Smith,[24] one-third occurred within 2 months of gastric resection and as early as 11 days in one. Roentgenograms in many of these demonstrated a typical filling defect with the small intestine pattern evident in the gastric pouch.

We have not encountered acute enterocolitis after gastric resection, as have Williams and Pullan.[29] Each of their 10 patients experienced colicky abdominal pain, diarrhea, and vascular collapse a few days after operation, and 5 of them died. Similar observations were reported by Dawson-Edwards and Morrissey[2] in 5 fatal cases. The etiology of this complication remains obscure.

Despite the abundant blood supply of the stomach, extensive devascularization may result in necrosis, as in the case reported by Rutter.[23] Thrombosis of the hepatic artery secondary to operative trauma, with subsequent hepatic failure and death, was mentioned by Kurzweg.[8] Bacterial peritonitis, not due to leakage from the gastrointestinal tract, is currently a rare complication.

DISCUSSION

To obtain a more complete view of the intra-abdominal complications following subtotal gastrectomy, we have combined the reported experience of others (Table VI).[3-5, 11, 13, 14, 16, 18, 22] The only reports included are those covering the years since 1946, when antibiotic agents, blood transfusion, and other relatively new surgical aids have been readily available. Failure of the authors to include emergency operations, incomplete tabulation of complications, and variation in resectability rate made collection of comparable data difficult. Nevertheless, this collection of cases provides a reasonably

TABLE VI. INCIDENCE OF INTRA-ABDOMINAL COMPLICATIONS AND RELATION TO MORTALITY FOLLOWING SUBTOTAL GASTRECTOMY FOR PEPTIC ULCER

COMPLICATION	V. A. HOSPITAL HOUSTON, TEX. (406 CASES)		COMBINED SERIES (1,797 CASES)	
	NUMBER	PER CENT	NUMBER	PER CENT
Gastric retention	7	1.7	85	4.8
Gastrointestinal bleeding	14 (1)†	3.5	37 (2)†	2.1
Leakage, duodenal stump	10	3.4*	26 (11)†	1.5*
Leakage, gastroduodenostomy	2 (1)†	1.8*	1	0.6*
Intra-abdominal infection	9	2.2	12	0.7
Injury, common bile duct	1	0.2	6 (2)†	0.4
Adynamic ileus, severe	2	0.5	5	0.3
Jaundice, transient	1	0.2	5	0.3
Intestinal obstruction	4	1.0	3	0.2
Intra-abdominal bleeding	3	0.7	3 (2)†	0.2
Pancreatic fistula	1	0.2	3 (2)†	0.2
Acute pancreatitis	1	0.2	2 (2)†	0.1
Acute cholecystitis	0	–	1	0.06
Acute diverticulitis	0	–	1	0.06
Leakage, duodenal biopsy	0	–	1 (1)†	0.06
Pancreatic cyst	0	–	1	0.06
Esophagitis	1	0.2	1	0.06
Leakage, gastrojejunostomy	1 (1)†	0.2	0	–
Small intestine fistula, external	1	0.2	0	–
Laceration of spleen, operative	2	0.2	0	–
	60 (3)†	14.8	193 (22)†	10.7
Total case fatality rate	2.7 per cent		2.1 per cent	
Proportion deaths due to intra-abdominal complications	27.3 per cent		57.9 per cent	

*On basis percentage of patients having Billroth I or II type resections.

†Deaths in which complication directly accountable or major contributing factor listed in parentheses.

accurate picture of the problem as a whole. Gastrointestinal bleeding, leakage of the duodenal stump, and gastric retention were consistently the 3 most commonly encountered complications.

In the collected series, comparative data for gastric versus duodenal ulceration were not presented often enough to warrant tabulation, but in our experience the difference has been striking, as no deaths have followed resection for gastric ulcer and the incidence of intra-abdominal complications was only 3.2 per cent. Whereas it is not anticipated that this extremely low case fatality rate can be maintained, an elective gastrectomy for uncomplicated gastric ulcer should be accomplished with a case fatality rate not greatly exceeding that for uncomplicated appendicitis. Thus, we advocate gastrectomy as the treatment of choice for gastric ulcer, since recurrence of ulceration and development of severe postgastrectomy sequelae are both uncommon.

SUMMARY

A detailed analysis of intra-abdominal complications following distal subtotal gastrectomy for benign gastroduodenal ulceration is presented. In a consecutive series of 406 resections, the incidence of complications was 14.8 per cent.

Gastrointestinal bleeding, duodenal stump leakage, and gastric retention were the most commonly encountered complications both in this series and in a collected series.

The case fatality rate was 2.7 per cent for all operations but was only 0.3 per cent following elective resections.

In only one instance was intra-abdominal complication a direct cause of death; it was a contributing cause in 2 other fatalities.

Subtotal gastrectomy is recommended as the treatment of choice for all gastric ulcers and for the complications of duodenal ulcer.

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RECONSTRUCTION OF THE BILE DUCTS

An Experimental Study Using Free Arterial Grafts and Nylon Mesh Tubes

Manuel Santos, M.D.,* Max L. Smith, Lieutenant Colonel, MC, USA,** Carl W. Hughes, Lieutenant Colonel, MC, USA,*** and Philip A. Riley, Jr., Captain, MC, USA,****
Washington, D. C.

(From the Division of Surgery, Walter Reed Army Institute of Research, Walter Reed Army Medical Center)

STRICTURE of the common and hepatic bile duct has been referred to by Lahey[13] as a surgical catastrophe. This complication often requires multiple surgical procedures for relief of symptoms. It is generally agreed that approximately 80 per cent of the strictures result from surgical injuries during cholecystectomy. Cattell[4] cites the example of 123 patients on whom 344 operations were performed. These results are typical of the best reported in medical literature. The repeated or extensive surgery for biliary stricture is similar to that required for malignancy in the multiplicity and frequency of procedures and the often fatal outcome.

Von Winiwarter[38] is credited with having performed the first biliary anastomosis in 1880. In the intervening 75 years, a great variety of ingenious procedures have been attempted, but only one indisputable principle has emerged; namely, that if at all possible, an end-to-end anastomosis of the duct should be performed. This principle, advocated by Voelcker,[36] has been widely propagated by the Lahey Clinic.[14, 15] The problem of repairing a massive defect in the common duct still remains, especially in the absence of any proximal duct other than the intrahepatic radicles. Almost as many procedures have been advocated as there are surgeons who do this type of surgery. This leaves the surgeon in a state of confusion and the unfortunate patient with diminishing hopes of having his problem attacked with any degree of success.

The techniques, both clinical and experimental, that have been devised in the past to meet this problem may be briefly classified as follows:

I. Bilidigestive Anastomosis
  A. Cholecystoenterostomy
  B. Cholangioenterostomy
    1. Hepaticoenterostomy (common hepatic bile duct anastomosed to stomach or small intestine)

*Instructor of Surgery, Universidad de Chile (Catedra Prof. Velasco S.), Contract Surgeon to the Chilean Army.
**Assistant Chief, Department of Surgery, Walter Reed Army Hospital.
***Director, Division of Surgery, Walter Reed Army Institute of Research, Walter Reed Army Medical Center.
****Experimental Surgery, Walter Reed Army Institute of Research, Walter Reed Army Medical Center.
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2. Choledochoenterostomy (common bile duct implanted into stomach or small intestine)
3. Intrahepatic cholangiojejunostomy (Longmire)

C. Fistuloenterostomy (biliary fistula anastomosed to intestine)

D. Hepatoenterostomy (liver cut surface to gut)

II. Plastic Repairs

III. Free Grafts

Bilidigestive Anastomosis.—Of these, cholangioenterostomy has achieved wide acceptance in the form of cholangioduodenostomy, and cholangiojejunostomy, utilizing the defunctionalized Roux-Y jejunal loop. Mayo[21] in 1905 first reported hepaticoduodenostomy in the United States. This procedure has been used extensively by Walters[39, 40] who reports good results in 70 to 75 per cent of his cases. The use of the Roux-Y loop of jejunum was first proposed by Moyniham[25] and strongly advocated by Cole[6] and his colleagues. They reported good results in 73 to 78 per cent. Sheibe,[33] however, in 1951, in reporting experimental work on the use of the Roux-Y, pointed out that cholangitis and periportal inflammatory changes occurred in all experimental dogs that survived. Modifications of the Roux-Y anastomosis, such as those of Allen[1] in which a splinting tube is brought out through the jejunum and abdominal wall, have been added.

Fistuloenterostomy was first proposed in 1906 by von Stubenrauch.[37] This procedure has been tried by many surgeons but usually fails because of stricture formation of the fistula.

Refinements of the hepatoenterostomy have been devised. Longmire[18] resects a part of the left hepatic lobe, finds a portion of duct, and anastomoses the jejunum to the duct. Hepp and Couinaud[9] uncover the left hepatic duct without resection of the left lobe.

Plastic Repairs.—These comprise (1) end-to-end anastomosis, (2) local plastic repairs of strictured areas of the duct, and (3) use of tubes, either alone or surrounded by adjacently available tissue.

Voelcker[36] recommended that when an end-to-end anastomosis is performed, a T tube be used, bringing out the vertical arm either above or below the anastomosis. As previously indicated, this is considered one of the ideal procedures. Cattell[4] feels that the distal end of the duct can always be found by mobilizing the duodenum and freeing the head of the pancreas posteriorly. However, not all surgeons have been able to accomplish this and the percentage of good results varies. Walters[39, 40] reported good results in 50 per cent, Cole[6] 63 per cent, and the Lahey Clinic[15] approximately 80 per cent.

Rogers[28] has used the left hepatic duct experimentally to by-pass a defect in the common duct preserving the sphincter of Oddi.

Strictures may be treated by dilation, spur cutting (Heineke procedure), and longitudinal incision and transverse closure (Heineke-Mikulicz procedure). There have been some successes with all of these procedures.

Tubes of a variety of materials have been used to bridge defects in the common duct. Rubber and vitallium have been tried most frequently. Most of these have failed because a high percentage of them have become occluded.

Pearse,[27] in 1951, reported 7 clinical failures with vitallium. Occasional success is reported in which a tube, covered by adjacently available tissue, is used to bridge a defect. This tissue may be secured from the stomach, duodenum, gall bladder, posterior peritoneum, omentum, or fascia. Sullivan[34] developed a technique using buried rubber covered by omentum. Many authors have reported good results in using this technique.

Rubber, vitallium, silicon, quills, catgut rolls, absorbable magnesium, and many other materials have been used as tubes for splinting the anastomosed duct.[5, 20, 24, 26, 27, 30, 32] Some traverse the papilla of Vater and others do not. An ideal time exists for such a tube to remain in place. If the splinting tube is removed too soon, stricture of the duct may occur and if the tube remains in place too long, it becomes obstructed. Many methods have been devised to time the withdrawal of the tube. It may be brought out through the abdominal wall from the stomach, duodenum, or jejunum. It may be attached to the abdominal wall with a piece of nonabsorbable suture which can be cut to permit the tube to pass. Rubber, because of its flexibility, smoothness, ease of handling, and ready accessibility, has been the most frequently used material. Pearse[27] was the first to call attention to the fact that rubber produced an inflammatory response in and surrounding the bile duct. Cole[6] and Walters[39, 40] have further emphasized this point. Lary and Sheibe[16] have demonstrated experimentally the inflammatory reaction and stricture resulting from a rubber T tube to splint an end-to-end anastomosis.

Although T tubes are used most frequently to support an anastomosis, there are still some objections to their use. Regardless of how long the tube is left in place, a biliary fistula is created when the tube is withdrawn and some localized reaction persists at the choledochotomy site. This may be one explanation for the bad results in 20 to 50 per cent of the end-to-end anastomoses.

Free Grafts.—Free grafts, used only experimentally to date, have not been very successful. Tissues having some physiologic and anatomic resemblance to the bile ducts, such as ureter, fallopian tube, appendix, preserved bile-duct homograft, and small intestine have been tried. Veins, arteries, and polyethylene tubing have also been used.[3, 7, 8, 11, 17, 20, 22, 31, 35]

In reviewing the experimental work done on the repair of the bile ducts in which free grafts have been utilized, certain problems have become apparent. First, many dogs have died in the first few hours from no apparent cause. Second, other dogs died several days after operation from leakage at the suture line. Third, a large percentage of the long-term survivors developed perforated duodenal ulcers, cholangitis, and stricture in the grafted segment.

The cause of death in those animals dying in the first few hours might well be due to the spillage of bile during the operative procedure. Horral, Harkins, and co-workers[10] have shown that the lethal dose of bile intraperitoneally may be as low as 5 c.c. per kilogram of body weight.

Miles and Howard[23] found that animals dying within the first 10 hours following the intraperitoneal injection of large amounts of sterile or infected

bile had no gross abnormalities at autopsy. Bradycardia and extreme hypotension developed in these animals, which suggested the absorption of toxic amounts of bile salts. The blood bile salt level was often increased 25 times that of the normal.

Bile salts produce local tissue damage and increase permeability in the bowel wall, thus permitting the passage of virulent bacteria into the damaged tissues. In the dog, the bile is frequently unsterile and may itself introduce infection into the peritoneum. Bactericidal and phagocytic defenses are weakened in the presence of bile salts. In addition, edema, congestion, and even necrosis of the solid viscera and the reticulo-endothelial system with fluid loss and shock may occur.

Perforated duodenal ulcers are frequently found in dogs that survive several weeks after common duct grafting procedures. Almost invariably the common duct is completely obstructed in these cases. This strongly suggests the importance of the buffering capacity of the bile in dogs in neutralizing the gastric acid secretions. Bollman and Mann[2] have given strong experimental support to this concept. By ligating the common duct in dogs, these investigators have consistently produced duodenal ulcers.

Cholangitis is one of the complications found in late survivors. The sluggish bile flow, the presence of clostridia and other virulent organisms in the dog's bile and bowel, and the lack of broad spectrum antibiotic coverage are advanced as possible explanations.

In almost all of the long-term survivors of common duct graft experiments, strictures at the graft site have developed. Most writers have suggested failure of epithelization as the cause. Fibrosis of the connective tissue surrounding the graft is always found, however, even when epithelization has occurred. It is true that biliary sediment and concretion formation is least apt to occur in the epithelized graft. In contrast to the situation in grafting blood vessels, there is no constant head of pressure in the biliary tree to maintain a patent graft. It would appear that a framework similar to that in the blood vessel, which is not entirely replaced with scar tissue, might be indicated for a common duct graft. It is possible that the limited success achieved by others in utilizing veins as common duct grafts was due to the elastic tissue framework. Since a greater mass of elastic tissue is present in arteries, it seemed reasonable to further investigate the use of artery grafts preserved by various methods as well as synthetic material.

METHOD

Common duct grafts were inserted into 38 mongrel dogs weighing an average of 29 pounds. Homologous femoral artery grafts, preserved in Tyrode's nutrient solution at 4° C. for an average of 15 days, were placed in the first 10 dogs. Homologous frozen dried femoral artery grafts were inserted into a second group of 10 dogs. Fresh autogenous femoral artery grafts were placed in a third group of 8 dogs, while nylon mesh tubes were used in a fourth group of 10 dogs.

Throughout the operation, emphasis was placed on gentle handling of tissues, and meticulous technique was observed. Through a paramedian incision,

the common duct was exposed by placing traction on the duodenum. Noncrushing, toothed, arterial clamps were used to avoid injury to the duct and spillage of bile. After dissecting the duct free of the hepatoduodenal ligament and pancreatic tissue from the junction of the cystic duct to the duodenum, a 1 to 2 cm. segment of common duct was removed. A splinting tube of polyvinyl (36 cases) or polyethylene (2 cases) was inserted into the proximal common duct stump and fixed with a through-and-through 5-0 silk suture. The graft, 0.5 cm. longer than the defect produced, was then slipped over the plastic tube which was passed through the distal duct stump for a distance of 3 cm. into the duodenal lumen (Fig. 1). The anastomosis was accomplished with continuous everting mattress sutures of 5-0 silk (Figs. 2 and 3). The hepatoduodenal

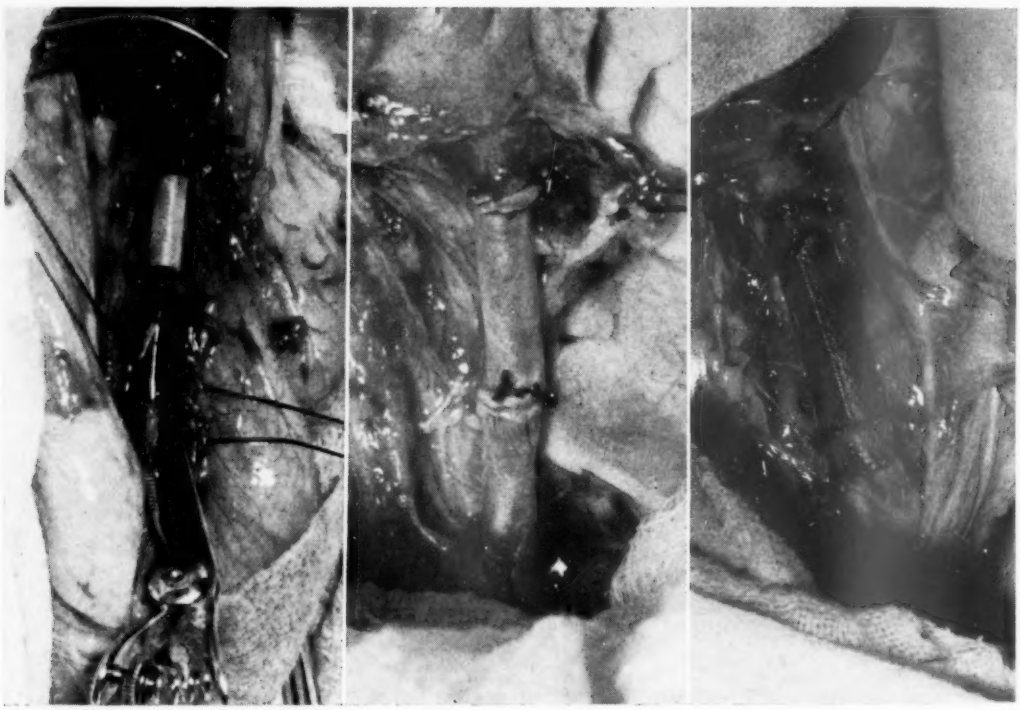

Fig. 1. Fig. 2. Fig. 3.

Fig. 1.—Traction on the duodenum by a Babcock clamp. Noncrushing toothed arterial clamps applied to common duct proximally and distally. The polyvinyl tube in place with the graft slipped over it prior to suture.

Fig. 2.—Arterial graft in place. The graft has been sutured in place with continuous everting mattress sutures of 5-0 silk.

Fig. 3.—Nylon mesh graft at the end of the operative procedure.

ligament was reapproximated over the common duct and graft. Before closing the abdomen, 300,000 units of penicillin and 0.5 Gm. of streptomycin were placed in the peritoneal cavity. Because of spillage of bile during the procedure, drainage of the abdominal cavity for 2 days was done in 6 of the 38 dogs. Penicillin, 300,000 units, and streptomycin, 0.5 Gm., were given intramuscularly, daily for 5 days. Regular ration was restored as soon as tolerated.

The plastic splinting tube deserves special description. The diameter varied depending on the lumen of the duct. Polyvinyl was preferred, because unlike

polyethylene it remained more supple when in contact with bile. Three longitudinal grooves were produced in the outer surface of the tube to permit capillary bile flow around as well as through it. The length was varied to permit 2 cm. to remain in the proximal duct and 3 cm. to project into the duodenal lumen. It was marked by 3 bands of tantalum for location by x-ray. This type of tube had been used previously in a series of 14 dogs for internal biliary drainage and was found to pass spontaneously in an average of 13 days when the anchoring suture included only thickness of the duct wall.[29] In this series, in order to maintain the tube in position for a longer period of time, it was anchored by a suture through the entire duct wall. In the series of 10 dogs where nylon mesh was used, the splinting tube was anchored to the nylon mesh with an additional suture of 20 day 3-0 catgut.

RESULTS

The animals were followed through a period of 8 months. Some of them died early during the postoperative course, others died after a longer period of time, while others were sacrificed for study.

Analysis of Early Postoperative Deaths.—In each of the 4 series, one early postoperative death occurred (Table I). One death on the sixth day was caused by intra-abdominal hemorrhage. A second animal died of asphyxia 4 hours after operation. The third animal died on the fifth postoperative day, but the cause of death could not be determined at autopsy. The fourth death occurred on the nineteenth day from ascending cholangitis.

TABLE I

PREPARATION USED FOR GRAFTING	NUMBER OF DOGS	COMMON BILE DUCT GRAFTS					
		POSTOPERATIVE DEATHS			SACRIFICED FOR STUDY FROM 1 TO 8 MONTHS		LATE SURVIVORS 8 TO 10 MONTHS
			LATE				
		EARLY	STRICTURED	PATENT	STRICTURED	PATENT	
Femoral artery preserved in nutrient solution	10	1	3	2	1	2	2
Frozen dried femoral artery	10	1	4	0	0	1	4
Autogenous femoral artery	8	1	3	0	2	1	1
Nylon mesh tubes	10	1	0	5	0	0	4

Analysis of Late Postoperative Deaths.—

Group I (artery graft preserved in nutrient solution): In Group I 5 late deaths occurred. Three were obstructed and succumbed at 104, 142, and 198 days, postoperatively. Two deaths occurred in dogs with patent grafts. One died on the sixty-eighth day with a subphrenic abscess and a retained gauze sponge at the operative site. The other died on the forty-fifth day with ascending cholangitis.

Group II (frozen dried femoral artery graft): In Group II there were 4 late deaths which occurred in 120, 130, 186, and 206 days after surgery, respectively. All of the grafts were replaced with scar tissue and were obstructed (Figs. 4 and 5).

Group III (fresh autogenous artery graft): In Group III there were 3 late deaths, occurring 98, 120, and 123 days postoperatively, respectively. All of these grafts were completely obstructed, at least functionally, even though in one a probe could be passed through the graft. All were jaundiced and had lost weight.

Group IV (nylon mesh tubes): In Group IV, 5 late deaths occurred 67, 137, 180, 194, and 210 days postoperatively, respectively. All deaths were due to ascending cholangitis. The nylon tube was lying free within the newly formed duct, which was composed of epithelial lined scar tissue.

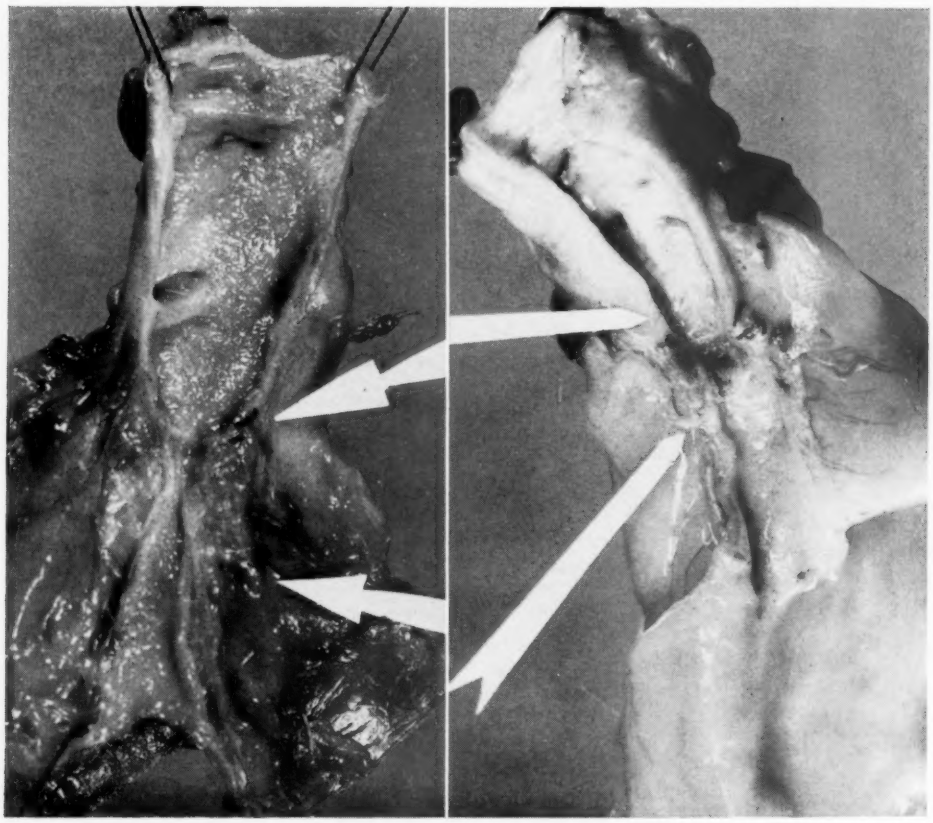

Fig. 4. Fig. 5.

Fig. 4.—Frozen dried homologous artery graft obstructed. Death occurred on the two hundred sixth day. The broad ring of fibrous tissue surrounding the graft is noted. The silk seen in the area may have provoked some of the foreign body response.

Fig. 5.—Frozen dried arterial graft at the end of 186 days. A stricture is present at the graft site.

Analysis of Animals Sacrificed Between the First and Eighth Month.—In Group I, 3 animals were sacrificed during this period. One animal on the fifty-fifth day had a strictured graft. One on the thirty-eighth day had a patent graft with a smooth lining, but the graft was 0.5 cm. shorter than when inserted. The third animal sacrificed on the fifty-sixth day was incompletely obstructed.

In Group II only one animal was sacrificed in this period. On the fortieth day the graft was found to be patent but the dog showed cholangitis and liver abscess.

In Group III, three animals were sacrificed during this period. Two were sacrificed at 70 and 114 days, respectively, and were strictured and jaundiced. One sacrificed on the thirty-eighth day had a patent graft, but it was friable.

In Group IV no dogs were sacrificed during this period.

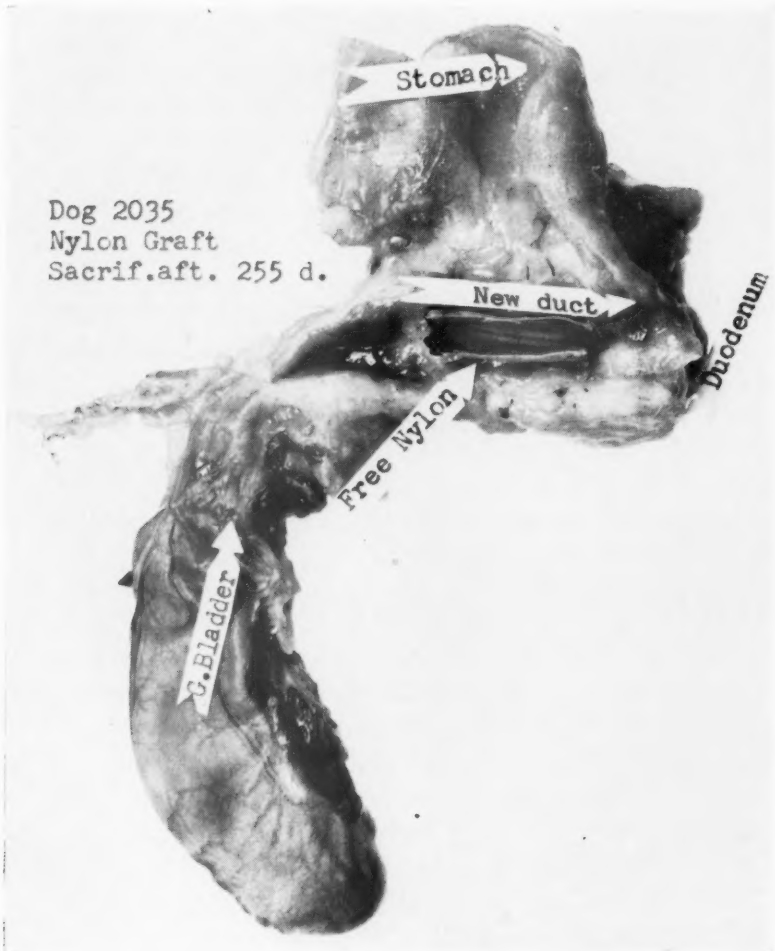

Fig. 6.—Nylon mesh tube used as a graft in the common bile duct of the dog. The tube has not been incorporated in the newly formed duct.

Analysis of Animals Sacrificed at Eight to Ten Months.—

The 11 animals which survived to this period were all sacrificed for study. Seven of these animals were survivors of arterial grafts. There were varying degrees of obstruction due to scar tissue replacement, even though some of the animals still remained healthy.

The 4 animals that survived in the nylon grafted group all had certain findings in common. The nylon graft was free within a newly formed duct

which was lined with biliary epithelium surrounded by scar tissue (Fig. 6). Infection was prominent within the duct and through its walls.

In the 3 groups where arterial grafts were used and the splinting tube was sutured to the entire thickness of the proximal common duct with 5-0 silk, these tubes passed after an average of 30 days.

In the nylon grafted animals which died in the late postoperative period, all of the splinting tubes, which had been fixed with additional 3-0 catgut, were still present.

DISCUSSION

This study was undertaken because a simple uniform method of bile-duct reconstruction is needed. Even in the specialized centers doing reconstructive common duct surgery, failures occur in 20 to 30 per cent.[13-15]

Experimental surgeons, using free grafts in the common duct, have been faced with 2 major problems—early death from a variety of causes and late stricture or obstruction of the grafted segment. Perhaps the greatest discouragement has arisen from the high rate of early postoperative deaths. This has varied from 14 to 57 per cent as reported by previous investigators.

Our experiment was designed as a pilot study directed at these 2 problems. Early postoperative death was not a problem with us. We credit this success to the careful avoidance of bile spillage during the procedure, to the gentle handling and meticulous approximation of the structures, and to the use of the internal biliary drainage by means of the splinting tube described.

We would like to emphasize the advantages of the internal biliary drainage in this study as opposed to the use of the T tube and its various modifications. Decompression and free drainage of bile from the common duct into the duodenum is very essential. Spasm of the lower end of the common bile duct after operative interference in the biliary tree results in increased pressure in the biliary system leading to infection and leakage through the choledochostomy wound. This is particularly true in the dog. The short armed T tube does not provide free passage of bile into the gut and is an inefficient decompressing agent. The long armed T tube does insure the passage of bile into the gut, but like the short armed variety it permits the leakage of bile from the choledochotomy and leaves rubber in contact with the duct. As Lary and Sheibe[16] have shown, the use of rubber results in stricture of the common duct 4 times as often as when no tube at all is used. Upon removal of a T tube, healing of the opening in the common duct must take place with added fibrosis and greater opportunity for stricture development.

As for the problem of stricture, grafts placed in the common duct serve as a framework and 2 processes are necessary for a successful result. Adequate circulation must be available from the surrounding structures for fibrous tissue replacement, and some method must be devised to maintain the tubular shape of the graft until the process of fibrous tissue replacement is complete.

After 8 months, results suggest that frozen dried arteries placed in the common duct are more resistant to the development of stricture than the fresh or nutrient preserved graft. Stricture was present in this group after an average time of 113 days. It was hoped that the nylon mesh tubes would become

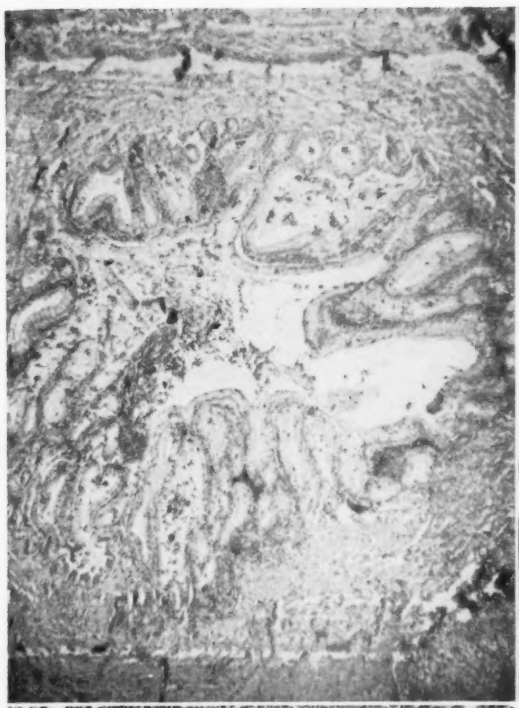

Fig. 7.

Fig. 8.

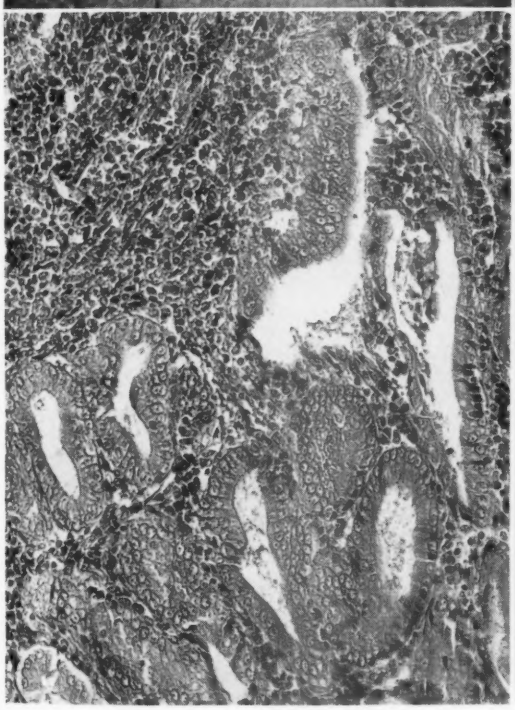

Fig. 9.

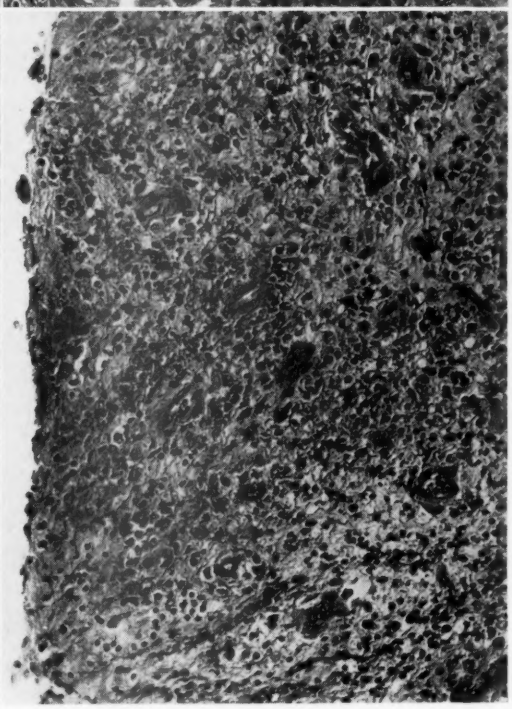

Fig. 10.

Fig. 7.—Fresh autogenous arterial graft from common duct of animal sacrificed on the eighty-sixth day showing jaundice, loss of weight, and obstructed duct. Section through the obstruction reveals intact epithelial lining surrounded by inflammatory and fibrous reaction.

Fig. 8.—Microscopic section through the proximal portion of the duct surrounding the nylon mesh tube showing the presence of biliary mucosa and inflammatory reaction.

Fig. 9.—Microscopic section through the distal portion of the duct surrounding the nylon mesh tube. The picture is similar to that of Fig. 8.

Fig. 10.—Microscopic section through the middle portion of the newly formed duct surrounding the nylon mesh tube after 255 days. The biliary mucosa has not completed the lining of the newly formed duct. In this portion the duct is formed exclusively of inflammatory tissue.

incorporated into a newly formed duct as occurs when they are used to bridge vascular defects. This incorporation of the nylon graft failed, perhaps because of the septic condition of the bile in the dog.

By random sampling of the bile of many dogs, we have consistently found contamination by the following microorganisms: *Micrococcus pyogenes,* Anaerobic streptococci, *Streptococcus fecalis. Clostridium perfringens, Escherichia coli,* and *Corynebacterium sp.* Since infection is to be expected, it would seem to indicate that a prolonged coverage with antibiotics should be provided. None of our animals were so protected for longer than 5 days. Microscopic study demonstrated inflammatory reaction and the presence of polymorphonuclear cells as dominating features throughout the period of the experiment. It was also noted that epithelization of the graft does not prevent stricture which develops due to fibrous tissue reaction secondary to the inflammatory phase (Figs. 7, 8, 9, and 10). The presence of foreign body granulomas about the silk sutures, noted at autopsy, may indicate that silk in the common duct should be avoided. While this is a negative study and the number of animals is not great, it is hoped that these findings may help to contribute to the answer of the problem of repairing defects in the common duct.

SUMMARY

1. Clinical and experimental work on reconstruction of the bile ducts has been reviewed.

2. In the past, free vein grafts have given the most promising results as common duct replacements. Two main problems have faced experimenters—early postoperative death caused by bile peritonitis and late postoperative death resulting from stricture of the grafted segment.

3. On the premise that the elastic tissue of vein grafts provided the framework for reconstruction of the bile duct, arterial segments preserved by various methods and nylon mesh tubes were utilized.

4. A tube was devised to provide adequate internal biliary drainage preventing bile peritonitis and to serve as an internal splint for the grafts.

5. The presence of an epithelial lining in the graft does not protect against stricture.

6. Fresh autogenous artery segments, homologous artery grafts preserved in nutrient solution, frozen dried homologous arterial preparations, and nylon mesh tubes were used in 38 dogs. The frozen dried preparations were more resistant to stricture formation than the other 2 arterial preparations. Nylon tubes, although permitting the formation of a surrounding new duct, were not incorporated as part of the duct wall.

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SURGERY IN POSTGASTRECTOMY BLEEDING

HERBERT J. ROBB, M.D., AND WARREN O. NICKEL, M.D., DETROIT AND DEARBORN, MICH.

(From the Department of Surgery, Wayne State University College of Medicine, Detroit Receiving Hospital, and Veterans Administration Hospital, Dearborn)

BLOOD may usually be aspirated from the gastric pouch immediately following the subtotal gastrectomy. It is usually of minor quantity, quite temporary, and of no consequence. In rare instances, however, it is of a magnitude and persistance to cause some concern and require operative intervention.

Early, this bleeding may be from an unresected ulcer or, more frequently, from one of the suture lines of the gastrointestinal anastomosis. Treatment usually consists of gastric tube suction[2] with frequent irrigations, and on occasion, cleansing with a large stomach tube. Intragastric thrombin[1] and various topical hemostatic agents have been used. Blood replacement and a supportive regimen for shock are used. However, when the blood pressure continues to drop and active bleeding persists, surgical exploration is indicated.

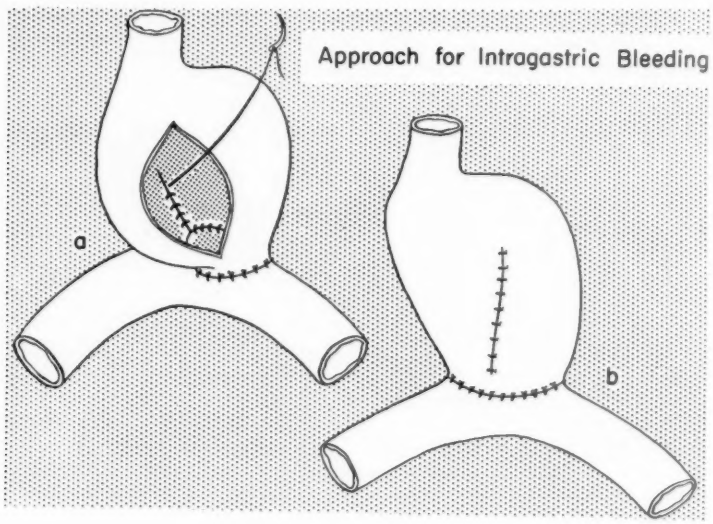

Fig. 1.

The usual approach to the problem of postgastrectomy bleeding has been to re-explore the stomach by re-entering at the site of the newly formed gastroenterostomy. If, however, a continuous suture has been used in the anastomosis, this may weaken the anastomosis to the degree that complete reconstruction of the gastrointestinal continuity must be done. This is time-consuming and more

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difficult than the original procedure. In place of this we describe a method which has proved very satisfactory for obtaining hemostasis in this type of problem. We feel this procedure is quicker, safer, and more practical than the practice of re-entering through the suture line of the previous anastomosis.

The abdomen is re-entered through the original incision. The gastroenterostomy and anterior wall of the stomach are visualized. A 1½ inch incision is made longitudinally in the anterior wall of the gastric pouch and vertical to the gastroenterostomy site, to within 1 cm. of the anastomotic site, as in the diagram. Blood and clots are now removed from the stomach. Traction on the lateral borders of the gastric incision will now make visualization of the anastomosis between the stomach and bowel readily possible. The site of bleeding has, in our experience, usually been along the gastric closure in the Billroth I or II type of procedure and easily visible. In order to insure complete hemostasis, a catgut suture is started along the inner posterior junction of the gastrojejunal anastomosis (Fig. 1, *a*). It is progressed in a running or locked fashion along the inner surface of the Hofmeister portion of the stomach. Traction upon each suture in turn will gradually bring this part of the stomach into view until complete hemostasis can be accomplished. The anterior row of anastomotic sutures may be likewise inspected and hemostasis obtained. A Polya type procedure can be approached in a similar fashion. The gastric incision is then closed as in any gastrotomy (Fig. 1, *b*).

In our experience, this has been a very satisfactory and relatively easy and quick method for an uncommon but occasionally difficult situation.

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SIMPLE CLOSURE FOR PERFORATED PEPTIC ULCER

J. J. McCaughan, Jr., M.D., and Ralph F. Bowers, M.D., Memphis, Tenn.

(From the General Surgical Service, Veterans Administration Medical Teaching Group Hospital)

RECENTLY some surgeons have employed emergency subtotal gastric resection for perforated peptic ulcer, duodenal as well as gastric. Although this extensive procedure has been used for many years by certain Russian surgeons[22] and later by other European surgeons,[10] American surgeons are really novices with this method and have not as yet gained a considerable experience. The time-honored and less extensive procedure, plication or simple closure, has proved to be excellent as far as mortality and early morbidity are concerned, and if these aspects were the only ones to be considered, the more extensive procedures would not have been introduced by anyone. The use of gastric resection is based on the fact that it might be possible to prevent the need of future significant medical therapy in the majority of the cases and subsequent gastric surgery and to gain control of the ulcer permanently by so doing. The advocates of the resection have presented mortality figures from 0 to 13.6 per cent[1-5, 7, 9-14, 17, 19, 20, 22] in favorable cases. Briefly, a favorable case means an early perforation (less than 8 to 10 hours) preferably in a young person, or if older, the patient's physical condition otherwise would be superb. At the same time, these operators subjected the less favorable and poor-conditioned patients to simple closure or plication which of course elevates the mortality rate of that procedure considerably but does not fairly represent the ability of that procedure to save life.

There has been a third nonoperative method for treatment of perforated ulcer by constant gastric drainage, antibiotics, and fluid balance. Most American surgeons who have tried the procedure have abandoned it because it is not as safe as simple closure or plication. Some English surgeons[18] distressingly report a mortality in the neighborhood of 14 per cent for this method. We have used the method 11 times; once in a mistaken diagnosis of acute cholecystitis in a cardiac patient which resulted in death of the patient from peritonitis, and the other ten occurred in patients who were admitted to the hospital several days postperforation with minimal symptoms and findings but with subdiaphragmatic air, as disclosed by the roentgenogram, and unquestioned ulcer. The perforations in these 10 patients were sealed by nature's processes and probably would have required only antiulcer therapy as applied to an active penetrating peptic ulcer. Therefore, this method is used only when we think the patient's perforation is adequately sealed for the purpose of maintaining security of the spontaneous closure.

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Ostensibly then, one is dealing with the problem of selecting an operative method for acute perforated peptic ulcer from two different procedures—one the simple operation of closure or plication and the second, subtotal gastric resection.

One must study the results, early and late, of each method if any real sensible use of the procedure is to be formulated. Preferably, it should be a procedure that can be used by all surgeons in all institutions, because the very emergency nature of the perforation demands promptness of action regardless of the type of procedure chosen. It is believed that if surgeons had a choice, they would prefer prompt action over type of operation, because it cannot be denied that mortality varies with length of time postperforation, even in this age of antibiotic defenses against bacterial invasion.

Mortality, morbidity, and subsequent fate of the patients for early and late complications and the need for medical or surgical therapy are presented.

Mortality.—The reported cases are included in the experience of a 10-year period ending Oct. 1, 1956. Two hundred seventy-seven instances of perforated peptic ulcer were diagnosed, treated, and studied. Space will not permit a discussion of the interesting and intriguing circumstances often accompanying the differential diagnosis and the pre- and postoperative management. Interestingly enough, perforation occurred twice in only 6 patients. There was no instance of a third or fourth perforation. The age distribution can be seen in Table I.

TABLE I. AGE INCIDENCE
(277 Perforations)

AGE (YEARS)	NO. OF PERFORATIONS
0-20	2
21-30	93
31-40	87
41-50	26
51-60	49
61-70	19
71-80	1

As stated above, 11 patients were treated by the nonoperative gastric drainage method. Another patient was unfortunately subjected to gastric resection when he was in exceedingly poor condition and 7 hours postperforation. It was an ill-chosen procedure which could not possibly have been expected to succeed and should not be counted as a score against gastric resection for this condition. Three patients received no therapy for the perforation because they were dying due to other fatal disease. Therefore, 15 perforated patients were not treated by closure or plication which leaves a total of 262 instances of perforation for the study. There were 9 deaths from perforated peptic ulcer in the entire group. But only 4 deaths occurred as the result of simple closure or plication. One death then was associated with nonoperative gastric drainage; one death followed gastric resection, mentioned above; 2 deaths occurred in dying and nonoperated cardiac patients; and one occurred in a patient dying of generalized carcinomatosis. The over-all hospital mortality rate for this

condition is 3.2 per cent (9 deaths in 277 perforations), but the mortality rate for the simple closure operation is 1.5 per cent (4 deaths in 262 operations). This low mortality rate (1.5 per cent) has been achieved in spite of a great number of patients with long hours postperforation, elderly, or in poor condition otherwise.

Causes of Death After Simple Closure or Plication.—1. Two died from overwhelming bacterial peritonitis. These were duodenal ulcers plicated 23 and 48 hours postperforation, respectively.

2. One patient, desperately ill with bilateral far-advanced pulmonary tuberculosis, died on the fourth postoperative day from massive hemorrhage of the plicated duodenal ulcer. This patient's life may have been salvaged by gastric resection at the time of the emergency operation. However, it is doubtful that any of the resectionists would have considered the condition of this tuberculous patient favorable enough for resection.

3. One duodenal ulcer patient died of suppurative pericarditis and subphrenic abscess 77 days following operation. This patient had been discharged from the hospital to return on the forty-ninth postoperative day. The patient was readmitted to the medical department. The cardiac difficulty overshadowed the import of postoperative suppuration. We feel that his death was due to suppuration which followed the operation and that the pericarditis was secondary to the subdiaphragmatic infection. Hence, the death reveals a failure of the simple closure-plication method.

Morbidity.—Early: Table II contains a list of the postoperative complications and will not require much embellishment. There were 40 complications (15.2 per cent). Wound infection, pelvic abscess, paralytic ileus, pyloric obstruction, and empyema are certainly complications attributable to the disease or the operation. Atelectasis, phlebothrombosis, and pleural effusion are complications that may appear in almost any type of major surgery. It is believed that the early morbidity is not particularly alarming when one considers that often this operation is performed in the presence of proved bacterial peritonitis or at least potential infection even in the most favorable

TABLE II. POSTOPERATIVE COMPLICATIONS
(262 Operations)

COMPLICATIONS	NUMBER	DEATHS
Wound infection	15	
Pelvic abscess	7	
Atelectasis	3	
Paralytic ileus	2	
Pyloric obstruction	2	
Hemorrhage	3	1
Empyema	2	
Pleural effusion	1	
Phlebothrombosis	1	
Peritonitis	2	2
Subphrenic abscess	1	1
Suppurative pericarditis	1	
Total	40 (15.2%)	

cases. We find that intra-abdominal abscesses are low in number. The incidence of pelvic abscess according to the study depends upon the length of postperforation time but more importantly upon the operator's ability to aspirate or mop from the pelvis most of the gastric or duodenal contents which have collected there. Surgical drainage was not required to effect successful disappearance of any of these pelvic abscesses. Only one patient demonstrated a subphrenic abscess. It is believed that 2 instances of pyloric obstruction and 2 gastrointestinal hemorrhages are significantly low and perhaps can be attributed to the skill of the operators. Approximately 90 per cent of these operations have been performed by senior surgical residents. Also, the study does not reveal long periods of invalidism from these few complications.

The 4 serious complications (2 pyloric obstructions and 2 hemorrhages) demand some comment. The early pyloric obstruction in one of the patients cleared under conservative therapy, but in the second patient with an obstruction a gastroenterostomy was successfully performed on the thirtieth postoperative day. One of the bleeding patients was easily controlled by medical therapy, but emergency subtotal gastric resection was needed in the second case and was successfully performed on the eighteenth postoperative day. It could properly be stated that resection instead of closure or plication would have probably prevented these serious nonfatal complications. However, 3 of these 4 patients were admitted to the hospital 10, 24 and 49 hours postperforation, respectively—hardly favorable enough for gastric resection as practiced by most of the resectionists today; consequently, 3 of these 4 patients would have received the closure or plication procedure by nearly all surgeons.

Late: This caption actually represents what has happened to these patients since discharge from the hospital after the closure or plication operation. It must be understood that all patients after closure or plication are sent to the gastrointestinal medical section for intensive antiulcer medical therapy as soon as it is obvious that the surgical phase of the treatment has been successfully completed, usually about the tenth to the twelfth postoperative day. Before transfer to that section, however, the patients are placed on a progressive milk and cream diet, with neutralizers, atropine, or Pro-Banthine. The average hospital days assigned to medical therapy alone are 21. In our opinion, medical management of the ulcer is imperative for the successful carrying out of the scheme of saving the stomach as long as possible for the patient, and we believe it indicates a lesser number of patients who require gastric surgery later. The resectionists base the rationale of their procedure on the poor showing of the peptic ulcer patient after the closure or plication procedure. Stabins,[15] in an excellent monograph on the problem, states that 65.1 per cent of the patients with perforated ulcer will develop major sequelae. Most experienced surgeons know that patients demonstrating long peptic ulcer histories in spite of intensive medical therapy and who experience one of the 3 complications (perforation, hemorrhage, or obstruction) will eventually need surgery if they are to be delivered from invalidism. According to the criteria for selection of cases for gastric resection ordinarily employed at Kennedy Hospital for chronic peptic

ulcer, only 25 (9 per cent) of the 277 cases met these requirements, which means that 252 cases could have been treated medically up to the time of perforation. An attempt was made to follow 223 patients whose ulcers perforated and were plicated prior to January, 1955. We have been able to follow 159 of the 223 patients operated upon for periods of time ranging from 2 to 10 years with an average follow-up time of 4.4 years. Letter follow-up was used in 8 patients. Sixty-four (40 per cent) have required definitive gastric surgery later. Sixty per cent have been satisfactorily controlled by medical management. Invalidism is not permitted, but if a patient can live a near normal life and requires hospitalization, say only one time in 5 years, we do not consider that an entirely unsuccessful event. According to observations of others, we can expect the need of operation in 10 to 20 per cent more of the patients as time passes. This would place the need of subsequent operation in about 50 to 55 per cent of the cases, a figure approximately 15 per cent lower than that reported by others.

Of the 64 patients who underwent subsequent operation, there were no deaths. The zero number of deaths following the second operation merely establishes the safety of the secondary procedure. It means that resection subsequent to the closure-plication operation is not more difficult or dangerous.

A second operation will be required in about 50 per cent of the cases and therefore it behooves the closure-plication surgeons to present good reasons for their conservatism.

The following reasons appear cogent to us.

1. It is almost a certain fact that widespread use of the resection cannot be performed with the presently reported favorable mortality and morbidity.

2. Subtotal gastric resection has not been proved to be as successful in the permanent control of peptic ulcer as some believe and many hope. Considerable comment could be made here, but one only needs to recall that peptic ulcer is presently being subjected to many different operative procedures because of dissatisfaction with the results of subtotal gastric resection. Some advocate the Billroth I resection and condemn the Billroth II type of resection or vice versa. Gastroenterostomy with or without vagotomy is employed by some former resectionists who flee the poor results of resection by returning to the more simple gastrojejunostomy. Some perform a simple pyloric resection plus vagotomy, others remove one-half of the stomach plus vagotomy, and still others remove two-thirds or more of the stomach with or without vagotomy. Wangensteen[21] and State[16] resect the upper part of the stomach instead of the antral portion. In the laboratory, Longmire and associates[8] are experimenting with the effect of mucosal resection, and Free and his co-workers[6] with mucosal resection plus skin graft. Why are these different procedures being employed or tried in the laboratory? Because subtotal resection has not proved to be the unquestioned solution to the problem of peptic ulcer control.

The resectionists state that control can be expected in 85 per cent of the cases and admit that the remaining 15 per cent are gastric cripples. But all seasoned and well-documented follow-up studies after gastric resection for

peptic ulcer show that the best results are obtained in properly selected cases, and the percentage of failure increases as the poor choice of patients increases. Some very definite generalities infiltrate most reports as follows:

1. Poor permanent results are commonplace in the young, particularly under 35 years of age and increase in proportion to the decreased age figure.

2. Poor permanent results follow if the patients are not properly oriented, physically or mentally, for gastric resection. This, of course, is impossible in the average patient with perforated ulcer who is "pulled from the street" for this operation.

3. Poor permanent results appear in some patients, particularly young patients, when psychosomatic influences create great overlay, apprehension, anxiety, and a spirit of invalidism almost hypochondriacal in type. Our experience reveals that this group of patients is better handled by prolonged medical care until which time the patient will often beg for the operation as a means of delivering him or her from chronic invalidism. Their cooperation and understanding are paramount and aid greatly in successful orientation.

4. Poor permanent results are often seen in the patient who believes that subtotal gastric resection will free him of all gastric disturbances, even minor ones, and permit him to be intemperate in eating, drinking, and other behaviors. Frustration and disappointment when the desired state is not achieved by operation add greatly to the patient's distress. Sensible watchful waiting with medical and psychosomatic aid will often permit this patient to accept the resection gracefully and successfully, but the time and maturity of reasoning and cooperation of the patient's part seem to be extremely important.

In other words, most experienced surgeons, if they have followed their patients carefully, become quite adept at choosing the patient who will receive a good result by resection and also in advising longer medical care and proper adjustment later if subsequent operation seems desirable.

Finally, it must be admitted that many of the patients with perforation who have received the simple closure-plication operation may live many happy years (as long as 10 and occasionally 15 years) before surgery is really needed for control. Common sense dictates that this period of gastric tranquility, perhaps with an occasional interruption, is exceedingly worthwhile to the patient. As stated above, each of these temporary gainers of gastric peace will then be older and by the age status alone be more acceptable for successful outcome.

One seldom encounters a surgeon who properly follows his gastrectomized peptic ulcer cases for years, who is a devotee of resection, and who does not employ careful consideration and some thoughtful and beneficial procrastination. The dumping syndrome, great weight loss, diarrhea, weakness, and gastric distress are not too often permanently observed in many well-chosen and properly operated patients, but they are distinctly more common in the poorly selected and improperly operated patients. When these complications appear,

the distress can lead to mild, moderate, or very severe crippling and formulate the reason for the present dilemma among surgeons as to type of resection or other procedure.

One could state also that resection in the early perforated gastric ulcer bears more likely chance of success than the duodenal ulcer, because it technically is easier and safer, more of them require subsequent operation, the permanent results are better, and an occasional early carcinoma may be more expeditiously handled, although the extent of the resection may not be properly done because of indistinct findings of carcinoma. One of our total gastrectomized patients for carcinoma enjoyed 7 years of good health before death. A simple closure-plication procedure preceded the total resection by 3 weeks. Nevertheless, if the ulcer is gastric and carcinoma is suspected or proved by biopsy and the proper anesthesiologic and surgical facilities and personnel are on hand, resection certainly is feasible. Comparatively, the number of cases found in this category will be small (228 duodenal, 2 stomal, and 41 gastric). There were only 3 instances of malignancy in the gastric ulcer group.

SUMMARY

1. Two hundred seventy-seven instances of perforated peptic ulcer have been treated during a 10-year period.

2. Two hundred sixty-two perforated ulcers received simple closure or plication as the emergency operation.

3. The fate and circumstances of 11 cases not treated by simple closure-plication are announced.

4. Mortality when simple closure-plication is performed is 1.5 per cent (4 deaths in 262 operations).

5. Sixty-four patients have required subsequent operation for permanent control of the ulcer. It is believed that approximately 10 to 15 per cent more of these patients will need operation as time passes. It means that approximately 50 per cent of the cases will need subsequent operation. This appears to be about 15 per cent below the figures submitted by others.

It is conjectured that the long and intensive postperforation medical therapy may be responsible for the lesser number of patients subsequently operated.

6. The mortality and morbidity of the subsequent operations have not been materially elevated over the same operation for well-selected chronic peptic ulcer patients.

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SPONTANEOUS RUPTURE OF THE STOMACH IN THE NEWBORN

A Report of Two Cases

John B. Moore, M.S., M.D., and Lillian Chan, M.D., Chicago, Ill.

(From the Departments of Surgery and Pediatrics, University of Illinois College of Medicine)

INTRODUCTION

SPONTANEOUS rupture or perforation of the stomach is rare as a cause of morbidity and mortality in the newborn age group. Only 70 cases have been reported to date. The first discussion of this subject was that by Siebold in 1825.[8] Prior to 1950, spontaneous gastric rupture in newborn infants had been reported as uniformly fatal. All but one case had been discovered at postmortem examination. Surgical repair of a gastric perforation in a newborn was reported by Stern in 1929,[9] but the infant did not survive the postoperative period. In 1950, Legar[6] reported the first successful repair, and in the last 5 years there have been 34 recorded cases of surgery for this disease. Of those operated upon, 23 have died, representing a mortality rate of 68 per cent.

This report adds 2 additional cases of spontaneous gastric perforation in the newborn to those previously recorded. Both infants were diagnosed preoperatively as having a perforated viscus and were operated upon. One infant survived postoperatively.

Case 1.—This Negro female infant had a normal spontaneous delivery. However, the labor had been prolonged with ruptured membranes for 24 hours prior to delivery without prophylactic antibiotics being given. The infant's feeding pattern for the first 30 hours was normal. Two meconium and two soft, yellow stools were noted prior to the onset of symptoms. Thirty hours after birth, the infant had an emesis of curdled milk, and it was noted for the first time that the baby's abdomen was distended. A second emesis and spitting up of small amounts of fluid occurred during the next few hours. The infant was now irritable and crying much of the time. Physical examination at this time revealed a moderately irritable newborn infant with an obviously distended abdomen. The vital signs consisted of a pulse of 140, respirations of 60 per minute, and a temperature of 99° F. rectally. The examination of the head and neck was not contributory. The lungs were clear to auscultation and percussion. The abdomen was moderately distended with prominent veins over the central and superior aspects. The abdominal skin was tense, shiny with erythema involving both lower and middle quadrants laterally and also around the umbilicus superiorly. The umbilical cord per se was dry and did not appear to be grossly infected. Both flanks appeared to be full with the infant in a supine position. The abdominal wall felt thickened and edematous, especially inferiorly and laterally. There was abdominal tenderness noted on palpation, particularly in the areas of erythema, which were warmer than the adjacent skin. There was questionable rebound tenderness throughout with shifting dullness bilaterally in the flank areas. The remainder of the abdomen was tympanitic to percussion. The bowel sounds were somewhat hypoactive but present. Rectal examination was not contributory. The white blood count was 16,000 with 72 per cent lymphocytes, 16 per cent monocytes, and 12 per cent neutrophils. The differential diagnosis at this time resolved itself to a consideration of either a peritonitis secondary to an omphalitis or a peritonitis

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originating from a ruptured viscus. A flat plate of the abdomen was noncontributory because an upright film was not included. It was the feeling of the combined surgical and pediatric staffs that an emergency celiotomy was indicated at this time. This opinion was based on the considerations that if this represented peritonitis secondary to a ruptured viscus, early surgical intervention was necessary for the infant's survival. If, however, the diagnosis were peritonitis secondary to an initial omphalitis, it was felt that a celiotomy would effect very little the final outcome. Consequently, celiotomy was performed 14 hours after the onset of the infant's symptoms.

Immediately upon incising the peritoneum, approximately 5 c.c. of yellowish, turbid material escaped, and as the abdominal cavity was entered it became obvious that a perforation of a viscus had occurred. The remainder of the peritoneal cavity contained copious amounts of curdled milk with mucus admixed. The stomach was exposed and was found to have perforated along the greater curvature in the area of the middle and lower third of its length. The perforation was approximately 2½ inches in length and the border of the perforated area was necrotic in appearance. The remainder of the stomach did not appear abnormal. The necrotic edges were trimmed back to relatively normal stomach wall and the perforated area was closed with 2 layers of continuous 3-0 chromic catgut sutures. Postoperatively the child was maintained on continuous gastric suction and intravenous fluids with electrolytes. For some strange reason good bowel sounds were present on the first postoperative day, and by evening of the same day the infant was having stools. Oral feedings were started on the sixth day after surgery. The infant continued to have an uneventful postoperative course.

CASE 2.—This premature Negro infant had a normal spontaneous delivery complicated by ruptured membranes developing 9 days prior to birth. The infant received antibiotic therapy for 3 days following delivery. The initial physical examination was not remarkable other than showing the evidence of prematurity. Feeding and physiologic functions were within the range of normal for the first 4 days. On the afternoon of the fifth day, the infant vomited 30 c.c. of her previous feeding. Following this she became quite listless and developed a distended abdomen. Bowel sounds at this time were present, but hypoactive. That evening the infant took her formula well, but 3 hours later, she again began to vomit; shortly thereafter she became cyanotic and developed shallow respirations. Oxygen per incubator was started. Throughout the night the infant vomited several times. By the following morning the abdominal distention had decreased somewhat, but the bowel sounds remained hypoactive. Penicillin and streptomycin parenterally were started. Two hours following this, it was noted that abdominal distention was again increasing and no bowel sounds were heard. A rectal suppository was inserted at this time and bloody mucus was noted coming from the rectum.

Physical examination at this time revealed edema of the skin of the anterior abdominal wall with rigidity present and most marked in the lower quadrants. Bowel sounds were absent and there was questionable evidence of free intra-abdominal fluid. The infant's temperature was 97° F. and the white blood count was 6,200. Roentgenograms were taken and revealed the presence of free air within the peritoneal cavity. A diagnosis of ruptured viscus was made and immediate surgery was advised. Approximately 22 hours after the onset of symptoms, celiotomy was performed under local anesthesia. As the peritoneum was opened, approximately 30 c.c. of greenish-yellow material was found free in the peritoneal cavity. A perforation of the greater curvature of the stomach immediately below the vasa brevae vessels 1 to 2 cm. in diameter was found. The edges of the perforation were necrotic and the surrounding stomach wall for a distance of 3 cm. in all directions was dusky gray in color. The perforation was closed in 2 layers, and abdominal exploration revealed no other pathology to be present. Postoperatively the infant did poorly and expired 5 hours postsurgery and 28 hours following the onset of symptoms. At autopsy no etiologic factors for the gastric perforation could be ascertained.

DISCUSSION

As implied by the numerous theories regarding the pathogenesis of spontaneous gastric perforation in the newborn, the cause of this clinical entity has

not definitely been proved. It is likely, however, that there is more than one factor involved. In an analysis of the world literature, Vargas and associates[10] reported that peptic ulceration of the stomach accounted for approximately 50 per cent of the cases reported. Prominent among the etiologic causes mentioned in the literature has been that of congenital defects of the gastric musculature. Several well-documented cases have shown defects in the gastric musculature at post-mortem examination. The congenital defect occurs primarily along the greater curvature of the stomach near the cardia. This is also the site of the greatest number of spontaneous gastric perforations in the newborn. Gastric distension most commonly found secondary to distal gastrointestinal obstruction has been reported as a cause of spontaneous perforation. Most of the reported cases have not shown distal obstruction at surgery or autopsy, however. Trauma to the stomach wall in the form of gastric lavage or a Levine tube is reported as a possible etiologic agent. The cause and effect relationship is fairly easily proved in these cases; they do not number many. Overwhelming septicemia in an infant with secondary ulceration and necrosis of the stomach wall has been discussed by several investigators as a possible etiologic factor, but in reviewing the reported cases it is to be noted that the majority of infants did not show a preceding septicemia prior to the onset of symptoms of perforation. Less likely causes of spontaneous gastric perforation in the newborn are such entities as gastric vessel thrombosis and central nervous system disease with secondary gastric ulceration.

In the majority of the reported cases, the clinical picture in spontaneous gastric perforation in the newborn presents a fairly constant group of signs and symptoms. The infants usually have a normal prenatal course and birth record. However, more than 50 per cent of the cases have occurred in premature infants. The significance of the high incidence of this entity in premature babies is not clear. The onset of perforation is predominantly within the first week of life and is preceded by normal stools progressing from the meconium type to milk stools. After the onset the infant may have melena and hematemesis, both being more common when peptic ulceration of the stomach is the etiologic cause. The onset of perforation is usually associated with restlessness and emesis and is followed subsequently by poor feeding on the part of the infant. Shortly after perforation, abdominal distension is noted and is usually associated with dyspnea and cyanosis. Abdominal distension is probably the most important sign of a perforated viscus in the newborn infant. The clinical picture of peritonitis with decreased to absent bowel sounds and abdominal distension and rigidity is often present; however, abdominal rigidity may be absent, and bowel sounds may be present. Edema of the anterior abdominal wall and flanks may be found as it was in both of the cases reported here. This physical sign may mislead the examining physician in the direction of a bacterial peritonitis secondary to an omphalitis. The white blood count and temperature may often be normal and should not mitigate against the diagnosis of peritonitis in the newborn. The most important single aid in diagnosis is the x-ray of the abdomen including both upright and lateral decubitus films. Free intraperitoneal air is pathognomonic of a perforated viscus.

The only treatment for spontaneous gastric perforation in the newborn is prompt surgery. The mortality rate in this disease may be correlated with the amount of time elapsing between the onset of perforation and surgical intervention. Preoperative preparations include a nasogastric tube of small caliber utilizing hand aspiration and venoclysis for the administration of appropriate intravenous fluids. In the majority of cases, local anesthesia is to be preferred. The infant can be kept quiet by allowing it to suck on a sugared bottle nipple. A 2-layer closure of the perforation is usually quite adequate after débridement of the necrotic edges back to normal stomach wall. Irrigation of the peritoneal cavity with body temperature physiologic saline solution and removal of all foreign material possible should be done prior to closure. Also important before closing the abdomen is a thorough inspection of all the intraperitoneal organs to exclude further pathology. Postoperatively, nasogastric suction and intravenous fluids are usually maintained for 48 to 72 hours, at which time glucose and water oral feedings are started. If the infant tolerates this, then diluted milk feedings may be started the following day.

SUMMARY

In reviewing the literature on the subject of spontaneous gastric perforation in the newborn, 70 cases have been reported. The addition of the 2 cases summarized in this report brings the total to 72 cases of which 36 have been operated upon. Twelve infants have survived surgical intervention. Fifty have died, with a resultant surgical mortality rate of 67 per cent. The most important physical signs and symptoms in gastric perforation in the newborn are feeding disturbance associated with abdominal distension and dyspnea. The most important diagnostic aid is an x-ray of the abdomen for free intraperitoneal air. The treatment of this entity is prompt surgical intervention. The mortality rate expected is almost directly proportional to the time elapsing between perforation and surgical closure of the perforation.

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GALLSTONES: SOLUBILITY STUDIES

ROBERT G. LUTTON, M.D., AND ALFRED M. LARGE, M.D., DETROIT, MICH.

(From the Department of Surgery, Wayne State University College of Medicine, and the University Surgical Service, The Grace Hospital)

IN 1903, it was shown by Harley and Barratt[2] that gallstones will gradually disappear when placed in the gall bladder of the living dog. This curious phenomenon of stones appearing in human bile and then gradually disappearing when placed in contact with bile of another species is an interesting one and immediately suggests the possibility of a relationship between any existing solubility factors and the actual etiology of the gallstones themselves[1, 3, 4] The present report is concerned with studies of the behavior of human gallstones in certain physiologic fluids both in vivo and in vitro.

METHOD

The gallstones used throughout these studies were mixed human cholesterol-pigment stones obtained by cholecystectomy and arranged in groups so that simultaneous studies could be carried out upon stones of almost the same composition.

Animal Experiments.—A single human stone was introduced into the gall bladder of each of 10 dogs, 2 pigs, 2 sheep, and 1 goat. The operations were performed under ordinary aseptic precautions but the stones were not sterilized beforehand. An opening was made in the gall bladder, the stone was inserted, and the opening in the gall bladder then was sutured with fine cotton. Care was taken not to pass the sutures through the mucosa itself. The stones were weighed wet prior to being placed in the animals' gall bladders. Then after varying periods of time the animals were reopened; the stones were removed and weighed again.

In Vitro Experiments.—An attempt was made to devise an apparatus which would insure a constant, slow, gentle flow of bile over the stone being tested in such a manner that no fragmentation would occur but that solution could take place if this were possible. After a number of different methods were tried, the apparatus shown in Fig. 1* was finally designed and seemed to serve the purpose very satisfactorily. The stone rests upon the small platform which is seen in the picture and is illustrated also in the diagram shown in Fig. 2. The bile or other fluid within the apparatus is constantly moved around in a clockwise direction by the suction of bubbles of air through the top of the apparatus, with each bubble of air drawing a certain amount of fluid across the upper limb of the arm with it as it passes over to the suction pump. Several such machines were set up and a series of stones

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*This apparatus was designed by Dr. John F. R. Kuck of the Department of Surgery.

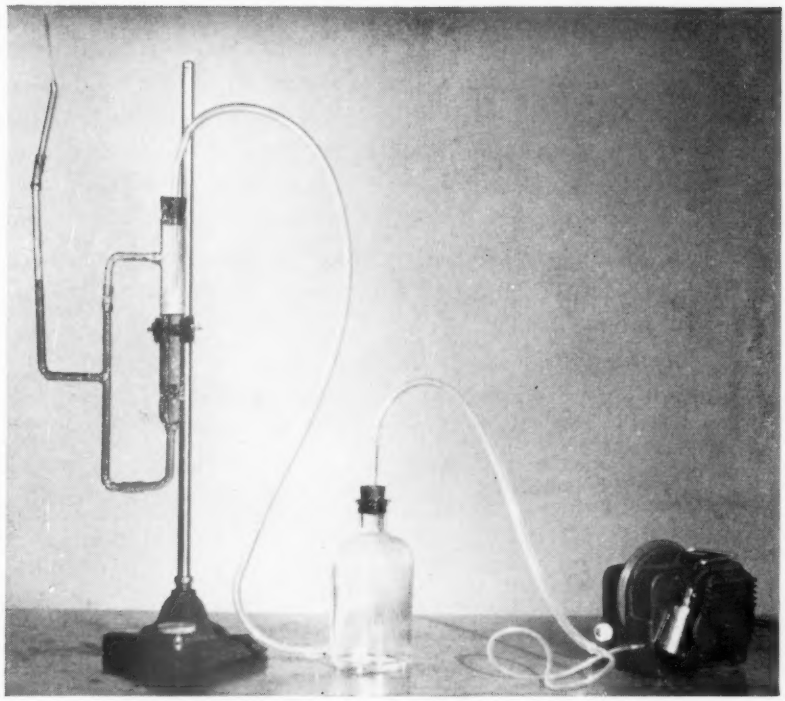

Fig. 1.—The apparatus used for testing the solubility of gallstones.

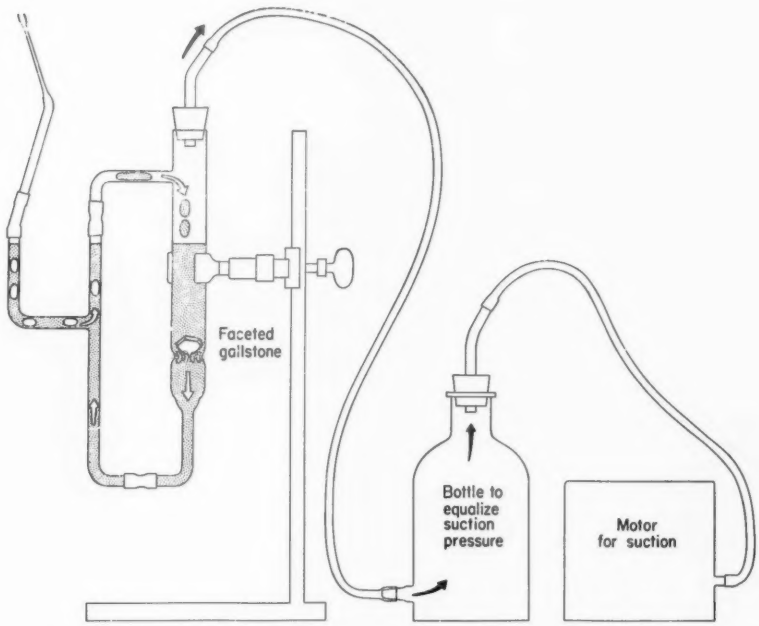

Fig. 2.—Explanatory drawing of the apparatus shown in Fig. 1.

exposed to distilled water within the apparatus for a period of one week to make sure that weight change would not be due to fragmentation of the stones. At the end of this period of time there was no significant change in weight of the stones and it was therefore felt that the apparatus was satisfactory. In the actual experiments, liver bile and gall bladder bile from the dog and liver bile from the human were all used as the fluid within the apparatus. Dog liver bile saturated with cholesterol also was used. Beta-propiolactone, which itself has no effect on the stones, was used as preservative for the bile in each case to inhibit fermentation and putrefaction.

The bile was allowed to pass slowly over the stone for periods of several days to 2 or 3 weeks, and changes in the weight of the stones were observed over this period of time.

To decide whether or not the change in stone weight could be a saturation phenomenon, in one experiment the bile was changed every other day for a period of 9 days but the weight loss of the stone was found to be the same amount and to occur at the same rate as when the bile was not changed at all. This is shown in Fig. 3. It was thus concluded that saturation was not a factor, at least for the duration of the studies performed.

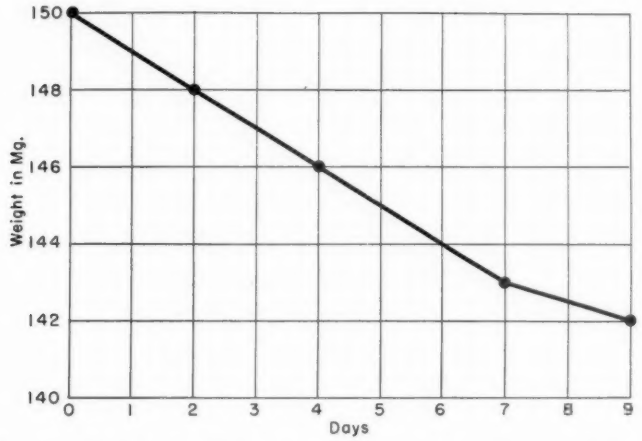

Fig. 3.—The uniform weight loss, which after 9 days is the same as if the bile had not been changed, indicates that saturation is not an appreciable factor in these experiments.

RESULTS

Animal Experiments.—The results of these experiments are listed in Table I. It is evident that the stones lost weight when they were placed in the gall bladder of any of the animals used; although there was considerable variation in the amount of weight loss it was quite constant in its occurrence, varying from a minimum of 0.7 per cent of the original weight daily loss to 2.9 per cent with an average of 1.7 per cent daily weight loss for the dogs and slightly less for the pigs, sheep, and goat.

In Vitro Experiments.—Results of these studies are shown in Table II. It would appear that the one result showing a stone weight loss of 2.5 mg. with cholesterol-supplemented dog hepatic bile as the solvent was due to fragmentation, since the other identical experiments showed such a small loss (0.06 mg.), and therefore it seems reasonable to discard this result. If this

TABLE I. RESULTS OF ANIMAL EXPERIMENTS

STONE GROUPS	ORIGINAL WEIGHT OF STONES (MG.)	LOSS OF WEIGHT (MG.)	PER CENT LOSS	NUMBER OF DAYS	DAILY WEIGHT LOSS OF STONES (MG.)	DAILY PER CENT LOSS OF WEIGHT	ANIMAL GROUP
1	482	399	83	44	9.05	1.8	Dog 1
11	315	304	96	45	6.76	2.1	Dog 2
21	908	604	66	52	11.60	1.2	Dog 3
31	208	48	23	34	1.41	0.7	Dog 4
41	148	130	87	32	4.1	2.8	Dog 5
51	266	202	76	26	7.76	2.9	Dog 6
4A28	348	309	88	49	6.32	1.8	Dog 7
4A28	156	98	63	77	1.27	0.8	Dog 8
4A28	230	70	30	18	3.90	1.7	Dog 9
18K8	154	94	61	39	2.41	1.5	Dog 10
1	155	37	23	47	0.80	0.5	Pig 1
11	159	94	59	78	1.20	0.7	Pig 2
1	888	852	96	142	6.05	0.6	Sheep 1
11	834	527	63	114	4.63	0.5	Sheep 2
11	890	604	68	72	8.40	0.9	Goat 1

TABLE II. DAILY WEIGHT LOSS OF STONES (MG.)

STONE GROUPS	DOG HEPATIC BILE	HUMAN HEPATIC BILE	CHOLESTEROL-SUPPLEMENTED DOG HEPATIC BILE	DOG GALL BLADDER BILE
1	0.77	0.06	0.06	4.94
1	0.89	0.00	0.06	4.64
11	0.84	0.00	0.06	4.00
11	0.96	0.05	2.50	3.56
21	0.32	0.32	0.06	
31	1.79	0.13	0.06	
41	0.57	0.13		
51	2.26	0.06		
6A11	0.69			
4A28	0.84			

TABLE III. DAILY WEIGHT LOSS OF STONES

Dog hepatic bile	1.03 mg.
Dog gall bladder bile	4.28 mg.
Human hepatic bile	0.09 mg.
Cholesterol-supplemented dog hepatic bile	0.06 mg.

is done the average daily weight loss of a stone when exposed in the apparatus to various types of bile is shown in Table III. Actual determinations of cholesterol and phospholipid content of these various biles are given in Table IV.

TABLE IV. CHEMICAL DETERMINATIONS—AVERAGE VALUES

	CHOLESTEROL (MG. PER CENT)	CHOLATE (MG./C.C.)	PHOSPHOLIPIDS (MG./C.C.)
Dog hepatic bile	19	15	14
Dog gall bladder bile	62	75	45
Human hepatic bile	70.0	2.24	2.12
Cholesterol-supplemented dog hepatic bile	75.0	--	--

COMMENT

The gradual disappearance of gallstones when placed in an animal's gall bladder might be due to the action of the bile upon the stone or to some action

of the gall bladder itself. The observation that stones gradually disappear when exposed to bile in a test tube shows that it is the bile itself and not the gall bladder which has caused the disappearance of the stone. Referring again to Table III, it is evident that dog liver bile, which is relatively low in cholesterol, will dissolve human stones without difficulty. The finding that this same dog bile when saturated with cholesterol no longer dissolves the stones indicates that the actual cholesterol content of the bile is an important factor in the solubility of the stone. This has been thought to be true by most persons for many years but to our knowledge has never been definitely shown in vitro until the present time.

The observation that gall bladder bile of a dog dissolves stones in vitro faster and better than does dog liver bile further indicates that some other substance must be present which in increasing concentration enhances this solubility, since, of course, gall bladder bile is more concentrated than is liver bile. In the past, it has been generally assumed that the bile acids are the most important factors in this phenomenon; however, studies now being conducted in our laboratories indicate that the phospholipids, particularly lecithin, may be equally or even more important than the bile acids in this regard.

SUMMARY AND CONCLUSIONS

Human gallstones when placed in the gall bladders of dogs, sheep, pigs, or goats will gradually disappear.

Gallstones exposed to gently agitated dog liver bile in vitro will gradually disappear but dissolve more rapidly when placed in contact with dog gall bladder bile. The same stones show no change in weight when exposed under the same conditions to human liver bile or to dog liver bile saturated with cholesterol.

These experiments show that the low cholesterol concentration in dog bile is an important factor in the solubility of gallstones and that the rising concentration of some substance in dog gall bladder bile (as compared with dog liver bile) is important in increasing the solubility of stones. It is suggested that phospholipids, as well as the bile acids, may play a part in this phenomenon.

It is reasonable to assume that factors which are intimately related to the solubility of gallstones may also play an important part in their formation. It is hoped, therefore, that further work of this type, in conjunction with detailed chemical studies, may shed some light on the true etiology of gallstones.

Dr. Charles G. Johnston stimulated our interest in this work and gave helpful advice and encouragement throughout the project.

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INTESTINAL OBSTRUCTION DUE TO PHYTOBEZOAR FOLLOWING GASTRIC RESECTION

Report of Two Cases

Robert R. Spurzem, M.D., and Penrose L. Desser, M.D., Los Angeles, Calif.

(From the Surgical Service, Wadsworth General Hospital, Veterans Administration Center)

INTESTINAL obstruction due to foodstuffs following gastric resection is a relatively rare occurrence. Only 12 cases have been found by us in the world literature. In a recent article, Norberg[6] presented 7 such cases; a review of the literature by the same author revealed 5 additional cases. For this reason, it seems worthwhile to present our experiences with this unusual complication of gastric resection. The 2 cases reported herein have occurred during the past year at the Wadsworth General Hospital, Veterans Administration Center, Los Angeles. A search of our records revealed no others of a similar type.

The type of food that causes obstruction has been varied, but citrus fruit is the most common. In 1930, Seifert[7] recorded the first such case due to sauerkraut. The 4 remaining cases, all due to orange pulp, were reported by Allen and Smithwick in 1942,[1] Baumeister and Darling in 1947,[2] Fleming and Ward-McQuaid in 1950,[5] and Elfving and Scheinin in 1953.[3] Four of the cases in Norberg's series were caused by oranges, one by grapefruit, and in 2, the nature of the obstructing mass was unknown, since it was "milked" into the cecum. In our cases, the obstructing material was figs in one and cocoanut fibers in the other.

In previously recorded cases, the site of obstruction was the distal ileum in all instances, but in the following 2 cases the jejunum was involved.

CASE REPORTS

Case 1.—J. A. F., a 68-year-old male laborer of Mexican descent, was admitted to the hospital on the night of Oct. 24, 1955. Two days prior to admission, he noted the onset of severe, crampy abdominal pain followed by repeated emesis and abdominal distention. In 1952, a subtotal gastrectomy with posterior gastrojejunostomy had been performed at an outside hospital for chronic duodenal ulcer. In 1953, a suprapubic prostatectomy was done in this institution for benign prostatic hypertrophy.

On admission, physical examination revealed an acutely ill, dehydrated man with a temperature of 99° F. The abdomen was distended with high-pitched bowel sounds and tenderness in the left lower quadrant. Laboratory studies revealed a white blood count of 19,900 cells per cubic millimeter, with 84 per cent neutrophils; hemoglobin of 16.8 Gm. per cent; serum amylase, 72 units per 100 c.c.; blood urea nitrogen, 29 mg. per cent; and a negative Kolmer serology. The specific gravity of the urine was 1.022, while microscopic examination showed 15 to 20 white blood cells per high-power field, occasional granular casts, and a trace of both sugar and albumin. An intestinal tube was passed and continuous suction employed. Roentgenograms revealed a dilated small bowel. The patient's pain

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and vomiting were relieved and hydration improved. The following day, repeat roentgenograms showed persistent small bowel distention with air-fluid levels, and surgery was advised.

At operation, an ovoid mass, approximately 6 by 6 by 8 cm., was found in the jejunum at the apparent site of the obstruction. The mass was removed through a longitudinal incision on the antimesenteric border of the intestine; a coalescence of vegetable fibers was disclosed. On being questioned after surgery, the patient recalled eating a large number of ripe figs 2 days prior to the onset of symptoms. The postoperative course was uneventful, and the patient was discharged on Nov. 7, 1955. On July 27, 1956, he was readmitted with signs and symptoms of bowel obstruction. Lysis of small bowel adhesions was performed on that date and recovery was uneventful. He had been well prior to this latest episode.

CASE 2.—W. W. B., a 43-year-old white man, was admitted to the hospital on March 1, 1956 with vague, crampy abdominal pain and emesis which persisted for 2½ days despite enemata and a "shot" administered by an outside physician. He gave a history of closure of a perforated duodenal ulcer in 1952, followed by a subtotal gastric resection with posterior gastrojejunostomy in 1953 at a Veterans Administration Hospital in Memphis, Tennessee.

On present admission, physical examination revealed a scaphoid abdomen which was minimally tender with hypoactive bowel sounds. Laboratory studies showed a white blood count of 11,400 cells per cubic millimeter, with 73 per cent neutrophils; hemoglobin of 15.4 Gm. per cent; serum amylase of 47 units per 100 c.c.; and a negative uranalysis. Roentgenograms revealed minimal small and large bowel gas. Gastric suction was started and parenteral fluids administered. On March 2, the white blood count was 12,000 cells per cubic millimeter, with 75 per cent neutrophils. Roentgenograms showed an increase in the small bowel distention, and the patient continued to have vague upper abdominal discomfort. The oral temperature rose to 101.4° F. that night.

At operation on March 3, 1956, an oval mass, measuring 6 by 8 by 10 cm., was found in the upper jejunum. A longitudinal enterostomy was performed to remove a large quantity of foul smelling, stringy cocoanut. When questioned on the following day, the patient recalled eating one-half of a box of shredded cocoanut prior to the onset of symptoms. His convalescence was satisfactory, and he was discharged 11 days after surgery.

DISCUSSION

Intestinal obstruction due to ingested material is common. Ward-McQuaid[8] reported 178 cases of small intestinal obstruction caused by some 45 different foodstuffs. The occurrence following gastric resection, although less frequent, would seem to be of significance. It is well known that the stomach empties more rapidly following the creation of an artificial stoma. All cases previously mentioned had a Billroth II type of reconstruction, and it would appear especially true with this type of anastomosis. Two additional cases of obstruction due to phytobezoars following gastroenterostomy reported by DelRio and co-workers[4] and Widmark[9] support this premise.

The bezoars usually contain undigested food and food fibers that are relatively hard to digest. In addition, the patients probably masticated the food poorly, which, plus the more rapid emptying of the stomach, predisposes these individuals to bowel obstruction. The cause of obstruction was not suspected preoperatively in either of the present cases. Therefore, it would seem worthwhile to question such patients about their eating habits and the type of food recently ingested wherever intestinal obstruction is encountered, particularly if a gastric resection had been performed previously.

Gastric resection must, therefore, be considered a predisposing factor to intestinal obstruction by foodstuffs. As a prophylactic measure, all patients after gastric surgery should be cautioned about eating large amounts of citrus fruits or other food high in fiber content.

SUMMARY

Intestinal obstruction due to phytobezoars following gastric resection has rarely been reported. A review of the literature revealed only 12 cases to date. Two additional cases encountered by the authors are described. Some of the etiologic factors are discussed, and it is suggested that phytobezoars should be suspected in any patient who, following gastric resection, suffers from bowel obstruction.

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PSEUDOANEURYSM OF THE LEFT VENTRICLE: DIAGNOSIS BY DIRECT CARDIOANGIOGRAPHY

Report of Two Cases Successfully Repaired

Ralph C. Smith, M.D.,* Harry Goldberg, M.D.,** and Charles P. Bailey, M.D.,*** Philadelphia, Pa.

WITH the recent rapid developments in cardiac surgical techniques, the use of ventricular myotomy incisions has become increasingly common. As open heart surgery becomes more widely adopted, the number of techniques utilizing exposure and repair through ventricular incisions will increase proportionately.

While it has become accepted widely that ventricular incisions heal without difficulty, it is the purpose of this report to show a complication of inadequate healing and to describe a technique for its diagnosis and repair.

The term pseudoaneurysm as used in this paper refers to a false aneurysmal sac whose walls are formed by pericardium and/or other adjacent extracardiac tissue and whose interior communicates with the ventricular lumen through the site of the previous cardiotomy incision.

While there are reports in the medical literature of previous operative attempts at plication[6, 9] and one of excision of a true aneurysm,[2, 13] it is believed that this is the first report of successful correction of a false ventricular aneurysm.

CASE REPORTS

Case 1.—Patient G. F., a 31-year-old white woman, was admitted to Hahnemann Hospital, on Sept. 16, 1955, for investigation of an abnormal shadow along the left cardiac border which had developed following a mitral commissurotomy procedure performed 4 months previously. She complained of moderate precordial discomfort at the time of admission.

There was a history of chorea at age 15 years, following which the patient remained asymptomatic and on full activity until age 23. Bouts of polyarthritis recurred over the next 2 years. She carried two pregnancies to full term without difficulty during the next 4 years. At age 30, during the summer of 1954, she developed slight exertional dyspnea, fatigue, and episodes

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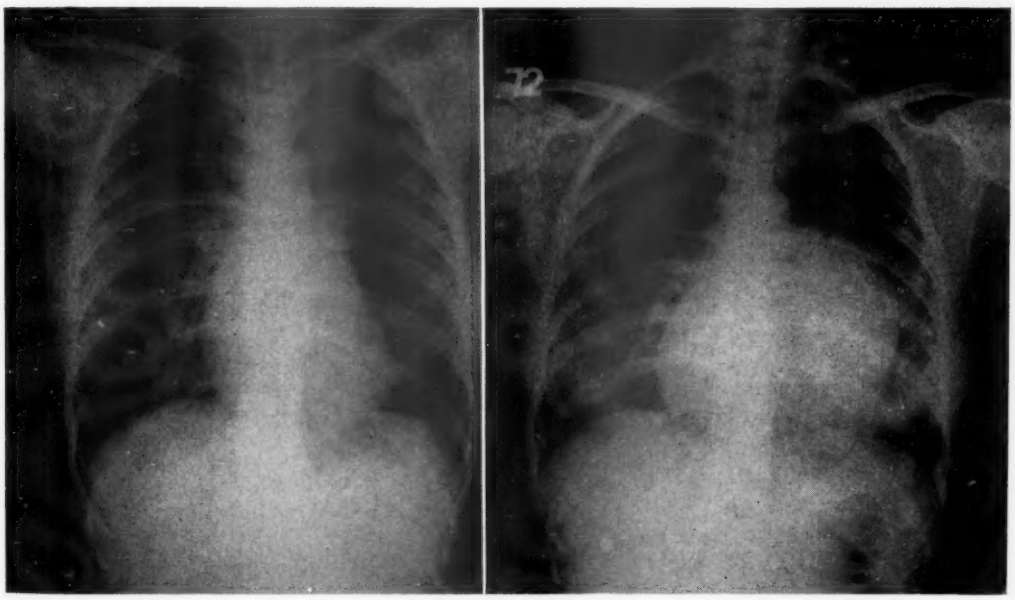
*Cardiac Surgical Fellow of Southeastern Pennsylvania Heart Association, Department of Thoracic Surgery, Hahnemann Medical College and Hospital of Philadelphia.

**Assistant Professor, Department of Medicine, Director, Brith Sholom Cardiopulmonary Laboratory, Hahnemann Medical College and Hospital of Philadelphia, and Cardiologist, Bailey Thoracic Clinic.

***Professor and Head of Department of Thoracic Surgery, Hahnemann Medical College and Hospital of Philadelphia, and Director, Bailey Thoracic Clinic.

of syncope. In November, 1954, she suffered an attack of paroxysmal nocturnal dyspnea lasting several hours. A diagnosis of mitral stenosis was made and the patient was placed on digitalis.

On May 8, 1955, at another hospital, she was subjected to a mitral commissurotomy procedure. During the operation, the surgeon inadvertently perforated the wall of the left ventricle from within while applying digital pressure to the anterolateral valve commissure. The laceration was repaired rapidly; however, considerable blood loss occurred and ventricular fibrillation ensued. Resuscitative measures were successful, and a normal cardiac rhythm was re-established. The chest was closed without further incident, and the patient left the operating room in a precarious condition. However, she improved gradually and finally was discharged in good condition. Her dyspnea was relieved. In August, 1955, an abnormal bulging shadow was first observed along the left cardiac border (Fig. 1, *A* and *B*). In view of the previous history, the possibility of a ventricular aneurysm was considered and her activity was restricted.



A. *B.*

Fig. 1.—*A*, Posteroanterior roentgenogram of Patient No. 1 (G. F.) just prior to original mitral commissurotomy procedure. *B*, Posteroanterior roentgenogram of same patient 3 months later showing an abnormal shadow superimposed upon that of the left border of the heart.

During the next few weeks, the shadow showed an increase in size and the patient developed precordial discomfort. On Sept. 16, 1955, she was admitted to Hahnemann Hospital for further evaluation.

Physical examination showed the following pertinent findings. The blood pressure was 100/60. There was no cyanosis nor neck vein distention. There was diminution in the breath sounds at the left base. Normal sinus rhythm was present with a rate of 84 per minute. The mitral first sound was sharp,

followed by a grade 1 blowing systolic murmur. A late mid-diastolic rumbling murmur was heard at the mitral area. The pulmonic second sound was accentuated. Peripheral edema and hepatomegaly were absent.

Laboratory studies: The urinalysis was negative. Hemoglobin was 11.2 Gm., the WBC 6,450 with a normal differential. The bleeding time, coagulation time, and prothrombin activity were normal. The total serum protein and A/G ratio were within normal limits. The electrocardiogram showed a normal sinus rhythm with a PR interval of 0.16 second. The ST segment was slightly elevated in Leads I, AVR, and AVL, depressed in Leads II, III, AVF, and V4 through V6. The T wave was inverted in Leads I and AVL. The tracing was suggestive of damage to the high lateral wall of the left ventricle. The ST depression in the anterior chest leads suggested coronary insufficiency (Fig. 2).

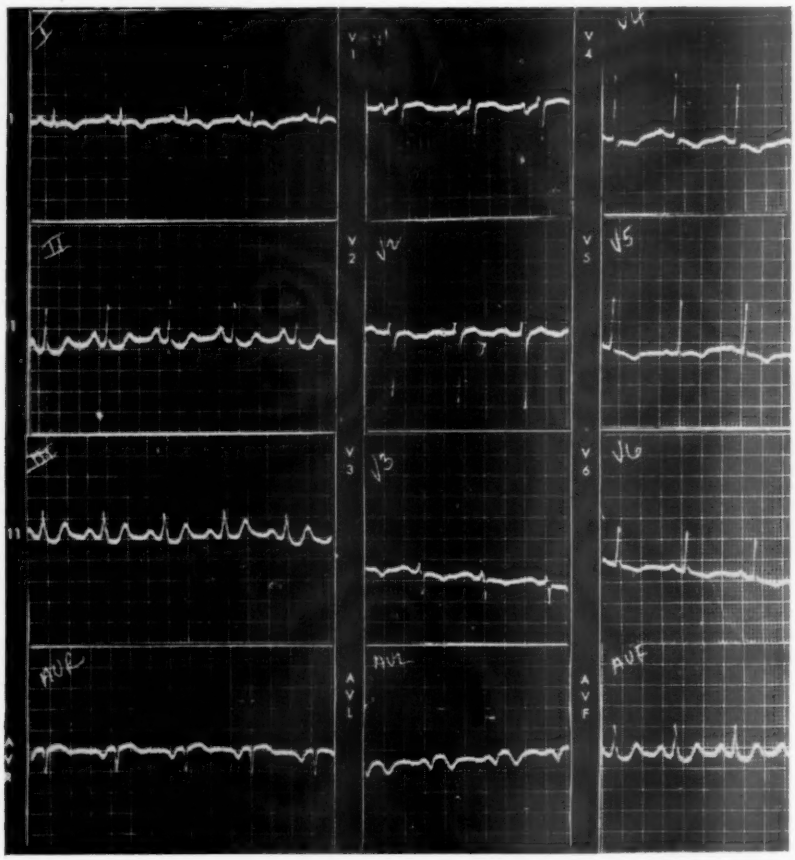
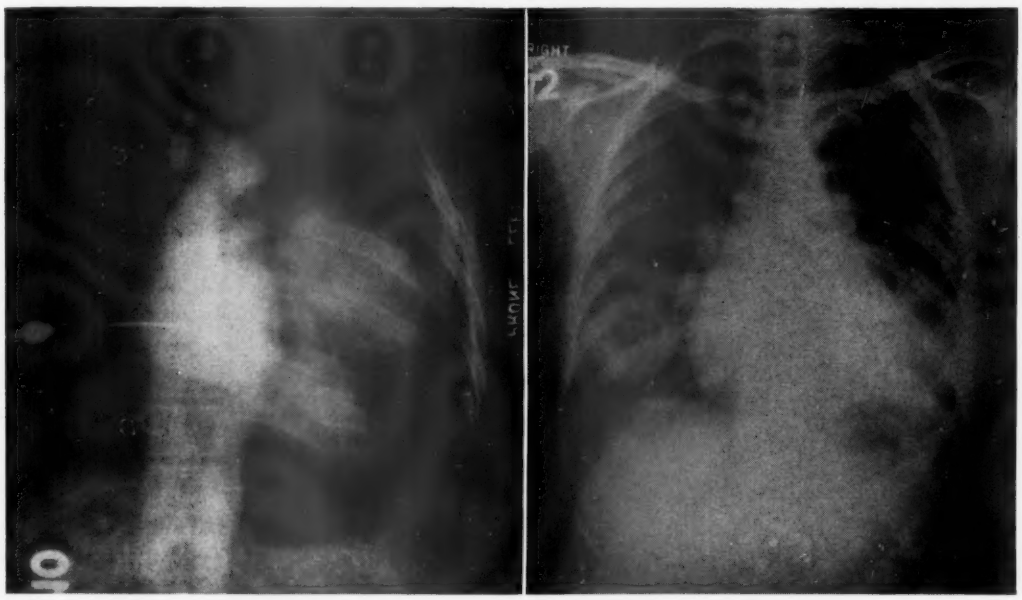


Fig. 2.—Electrocardiographic study of Patient G. F. prior to repair of a ventricular pseudoaneurysm.

Preliminary x-ray studies revealed an unusual cardiac silhouette. A bulge extended from just below the aortic knob to a point 3 cm. from the apex (Fig. 1, *B*). It appeared suggestive but uncertain that this bulge arose from the left ventricle. Pulsations of the bulge were prominent and paradoxical movement was observed under fluoroscopy. Irrespective of the bulge,

the cardiac configuration was that of mitral valvular disease showing grade 2 enlargement of the left atrium and the right ventricular outflow tract. There was no evidence of valvular calcification. Kymographic studies indicated the pulsations of the bulge to be 10 mm. in amplitude and paradoxical to ventricular systole.

Direct cardioangiography showed opacification of the bulge following visualization of the left atrium and simultaneous with that of the left ventricle. This was felt to indicate beyond doubt that the origin of the sac was from the left ventricle. The site of the communication between the two chambers was clearly visualized and the narrow caliber of the connection was demonstrated (Fig. 3, *A*). The bulge filled well and did not appear to contain clot.

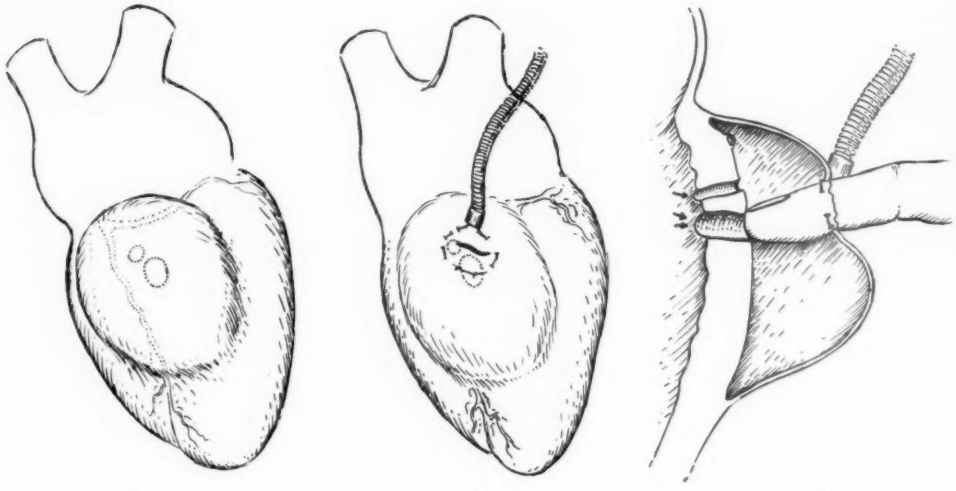


A. *B.*

Fig. 3.—*A*, Cardioangiogram obtained by direct injection of 70 per cent Diodrast into the left atrium in Patient G. F. Note simultaneous opacification of left ventricle, an abnormal (aneurysmal) chamber, and a narrow communicating channel. *B*, Postoperative roentgenogram obtained at the time of discharge following removal of pseudoaneurysm of the left ventricle.

On Sept. 27, 1955, the patient was explored with a preoperative diagnosis of left ventricular aneurysm arising from the site of the previous ventricular laceration. When the pericardial sac was exposed, the bulging, pulsating mass was visualized. It was apparent then that the thickened pericardium formed the outer wall of this mass (Fig. 4). A purse-string suture was applied to a circumscribed portion of the wall of the sac, and the operator's ungloved left index finger was inserted through an incision made within the confines of the purse string. It was confirmed then that this was a false aneurysm formed by thickened pericardium. There seemed to be no thrombosis within the sac. The communication with the left ventricular chamber could be palpated and blood was felt to emerge from the ventricle with each contraction. Indeed, it soon was realized that there were two such communications. These openings were in the upper basal portion of the cavity, separated

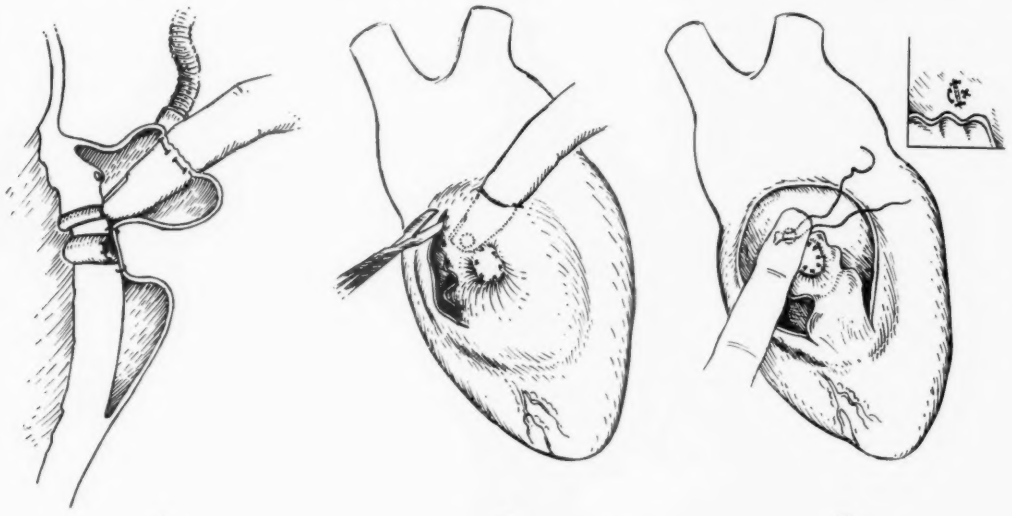
Fig. 4.—Actual photograph taken at the time of operation in G. F. showing the false aneurysmal sac largely formed from the thickened pericardium. Note phrenic nerve running over the sac.



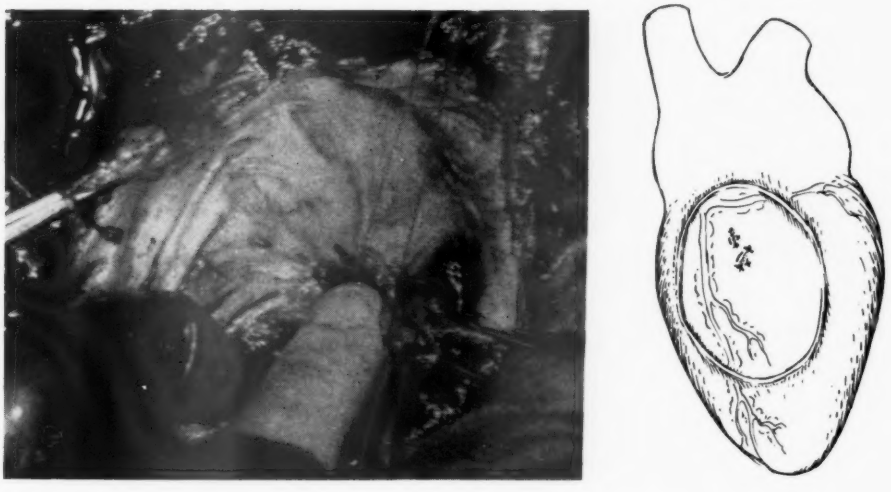
A. *B.* *C.*

Fig. 5.—*A*, Diagrammatic representation of the anatomic interrelationships between the false aneurysm in G. F. and the two ventricular communications. Note the proximity of the main branches of the left coronary artery. *B*, Incision of the fundus of the pseudoaneurysm within the confines of an encircling purse-string suture. *C*, Sectional view of the pseudoaneurysm and left ventricular wall showing the double communication and the feasibility of finger-tip tamponade of either opening (but not both simultaneously).

by a strip of normal ventricular wall 4 to 6 mm. wide, the lower one being somewhat the larger (Fig. 5, *A*, *B*, and *C*). Neither aperture was large enough to permit entrance of the tip of the exploring finger into the ventricle. Either could be tamponaded effectively with the end of the finger, one of the jets



A. *B.* *C.*



D. *E.*

Fig. 6.—*A*, Temporary occlusion of the lower (larger) opening into the ventricle by suturing down to its margin an invaginated portion of the aneurysmal sac. *B*, As the operator's finger-tip tamponades the upper remaining ventricular communications, the pseudoaneurysmal sac is opened widely. *C*, The upper opening is closed by the technique of suturing beneath the tamponading finger. *D*, Actual photograph showing direct suture repair of the lower opening following closure of the upper. The operator's finger restrains bleeding once the attached overlying portion of the aneurysmal sac has been removed. *E*, Diagrammatic representation of final repair of the two ventricular communications. The false sac has been cut away.

of emerging blood thereby being abolished. The heart tolerated these examinations and manipulations well and the blood pressure was maintained satisfactorily.

It was evident that either ventricular opening could be closed by the relatively simple technique of passing mattress sutures beneath a tamponading finger. The only problem was concerned with the possibility of concurrent hemorrhage from the second opening once the false aneurysmal sac was opened. This was solved by temporary occlusion of the lower (apical) communication by complete suture approximation of the overlying portion of the aneurysmal sac to its scarred fibrotic margins. The technique employed was nearly identical with that which is used for the correction of atrial septal defects by the method of atrioseptopexy.[3-5] As soon as the lower opening was blocked, the blood within the sac became coagulated (Fig. 6, *A*).

Once the lower passage was thus controlled, the peripheral portion of the sac was incised widely, while the upper (basal) one was tamponaded effectively with the finger tip. Medium-sized curved needles swedged onto 00 braided silk sutures were passed under the finger applying the necessary hemostatic mattress sutures. After the upper communication was abolished, the sutures binding the sac to the surface of the lower one were removed. The now exposed defect was tamponaded and undersutured in a similar fashion (Fig. 6, *B*, *C*, *D*, and *E*).

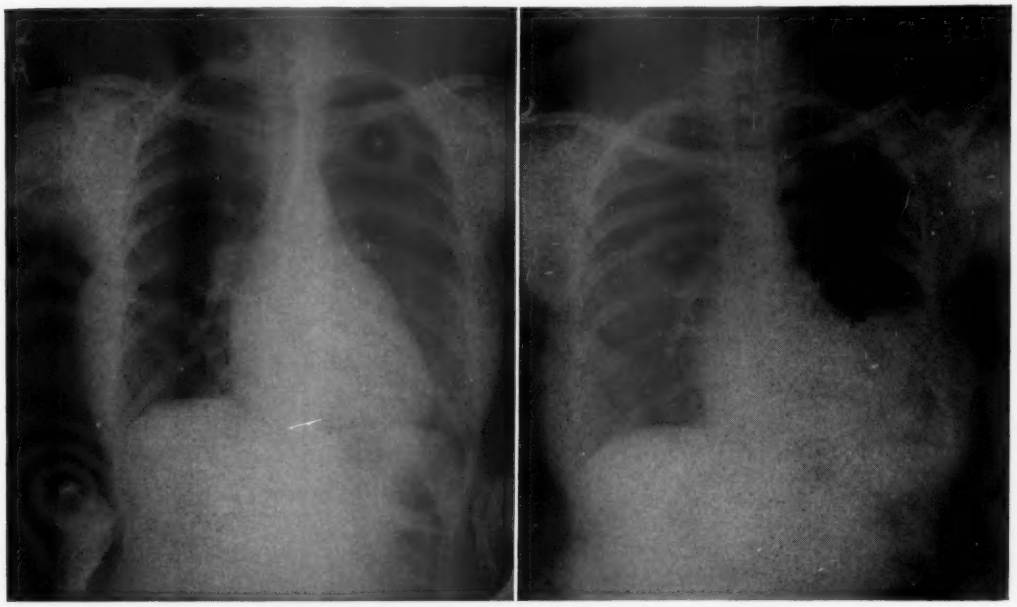
Subsequent to this repair, a mitral valve exploration was accomplished via an incision of the atrial wall at the base of the pulmonary veins. The thickened valve leaflets were stenosed to provide less than a finger-sized opening. Using the usual commissurotomy guillotine, the anterior commissure was opened to the annulus; the valve aperture became enlarged to a size estimated at 1½ fingers.

The postoperative course was uneventful and subsequent x-ray studies showed a more normal configuration of the left heart border (Fig. 3, *B*). The patient was discharged on the fourteenth postoperative day with no complaints. She remains well to date.

Case 2.—Patient E. S., a 38-year-old white woman, was readmitted to Hahnemann Hospital, on Dec. 6, 1955, complaining of shortness of breath and fatigue increasing over a period of 5 months. She had a history of rheumatic fever at age 8 years, following which her activities were unrestricted. From age 12 to 14 years, she experienced intermittent ankle edema and a chronic nonproductive cough. A heart murmur was first detected at 17 years of age. At the age of 19, she developed dyspnea and fatigue which progressively became worse over the next 15 years. At the age of 27, she was digitalized and the intermittent use of mercurial diuretics became necessary. She was admitted to Hahnemann Hospital for the first time in November, 1953, and was found to have combined mitral and aortic stenosis. Simultaneous combined valvular surgery was done; the aortic valve was approached by the transventricular route. Her postoperative course was without untoward incident and she was discharged on the fourteenth postoperative day.

During the next few months, improvement was noted and she returned to her work. Following an auto accident, in July, 1955, she developed atrial fibrillation, and a chest x-ray at that time revealed an abnormal bulge on the

left border of the cardiac silhouette. In retrospect, a similar bulge then was noted on an early postoperative film upon re-examination (Fig. 7, *A*, *B*, and *C*). Under observation, the bulge increased in size during the next 3 months, and the patient developed frequent attacks of paroxysmal nocturnal dyspnea. On Dec. 6, 1955, she was readmitted to our hospital for evaluation.



A. *B.*

C.

Fig. 7.—*A*, Posteroanterior roentgenogram of E. S. prior to simultaneous, combined commissurotomy for mitral and aortic stenosis in November, 1953. *B*, Postoperative roentgenogram showing a shadow in the left lower lung field which was thought to represent a residual pleural effusion. *C*, Roentgenogram taken nearly 2 years later showing persistence and increase in size of shadow in left lung field.

Physical examination: The patient was in no acute distress. Blood pressure was 100/70. At the aortic area, a harsh grade 3 systolic murmur was present. An early blowing diastolic murmur was heard along the left sternal border and over the apex. A mitral diastolic murmur was not audible. The apical systolic murmur overshadowed the mitral first sound. The pulmonic second sound was accentuated. The lung fields were clear and there was no hepatomegaly or peripheral edema.

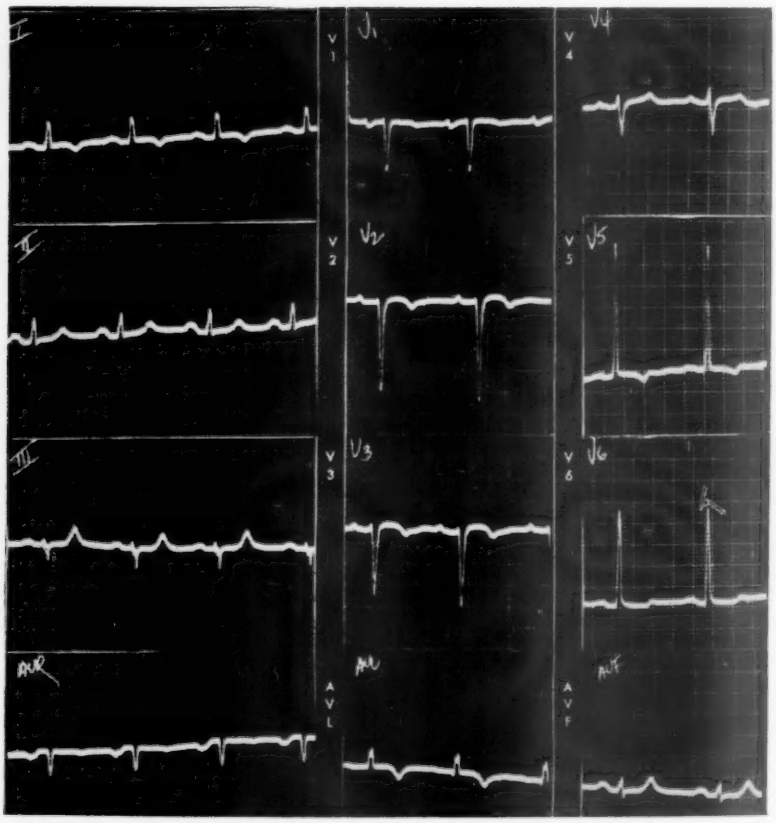


Fig. 8.—Electrocardiographic study in Patient E. S. carried out just prior to operation for pseudoaneurysm of the left ventricle. There is a suggestion of myocardial damage high on the lateral wall of the left ventricle.

Laboratory findings: The urinalysis was normal. Hemoglobin was 12.1 Gm. WBC was 7,600 with a normal differential. The usual blood chemistry values and blood clotting studies were within normal ranges.

The electrocardiogram showed T-wave inversion in Leads I and AVL, suggestive of myocardial damage high on the lateral wall of the left ventricle (Fig. 8). Bronchoscopy revealed only a minimal degree of compression of the left main bronchus. Sputum smears were negative for neoplastic cells and acid-fast bacilli. Preliminary radiograms of the heart revealed a large density in the lower left lung field contiguous with the left heart border and of a density equal to that of the cardiac silhouette (Fig. 7, *C*). The appearance was compatible with a diagnosis of mediastinal cyst, loculated pleural fluid, or

an aneurysm of the left ventricle. Roentgenokymography demonstrated pulsations of the mass which were thought to be transmitted, suggesting that it was not part of the cardiac silhouette but rather a mass at the left lung base. Planograms showed homogeneous density without any evidence of cavitation. Direct cardioangiography, however, clearly and conclusively demonstrated that this mass was part of the cardiovascular system and directly connected with the left ventricle from which it was filled (Fig. 9). The connecting portion was narrow and the extent of opacification showed little or no clot formation to be present.

Fig. 9.—Cardioangiogram in Patient E. S. showing a false aneurysmal chamber connected with the left ventricular cavity by a narrow communicating channel.

Left heart catheterization was carried out in order to evaluate the surgical result upon the mitral and aortic valves. The left atrial mean pressure was elevated to 25 mm. Hg. The left ventricular pressure was 140/10 mm. Hg. the left atrial–left ventricular filling pressure gradient was 8 mm. Hg. The aortic pressure was measured at 126/84 mm. Hg with a mean of 98 mm. Hg. These data indicated that a degree of mitral stenosis was still present. The aortic gradient was considered small, and further surgery for this valve was deemed unnecessary. Dynamic aortic insufficiency was not present.

On Dec. 16, 1955, surgical exploration was undertaken with a preoperative diagnosis of false aneurysm of the left ventricle arising at the site of the previous cardiotomy incision. At operation, after separating many overlying adhesions, an ovoid mass (Fig. 10, *A*) roughly the size of a lemon was seen to arise from the lateral wall of the left ventricle. It exhibited expansile pulsations and was readily compressible. The tip of the operator's ungloved left index finger was inserted into its lumen by way of an opening made into a purse-stringed portion of its wall (Fig. 10, *B* and *C*). A single ventricular communication 6 to 8 mm. in diameter from which a jet of blood emerged

with each systole was recognized. The opening was tamponaded with the finger tip while the sac was cut away peripherally. Occluding mattress sutures were placed by passing curved needles beneath the finger (Fig. 10, *D*).

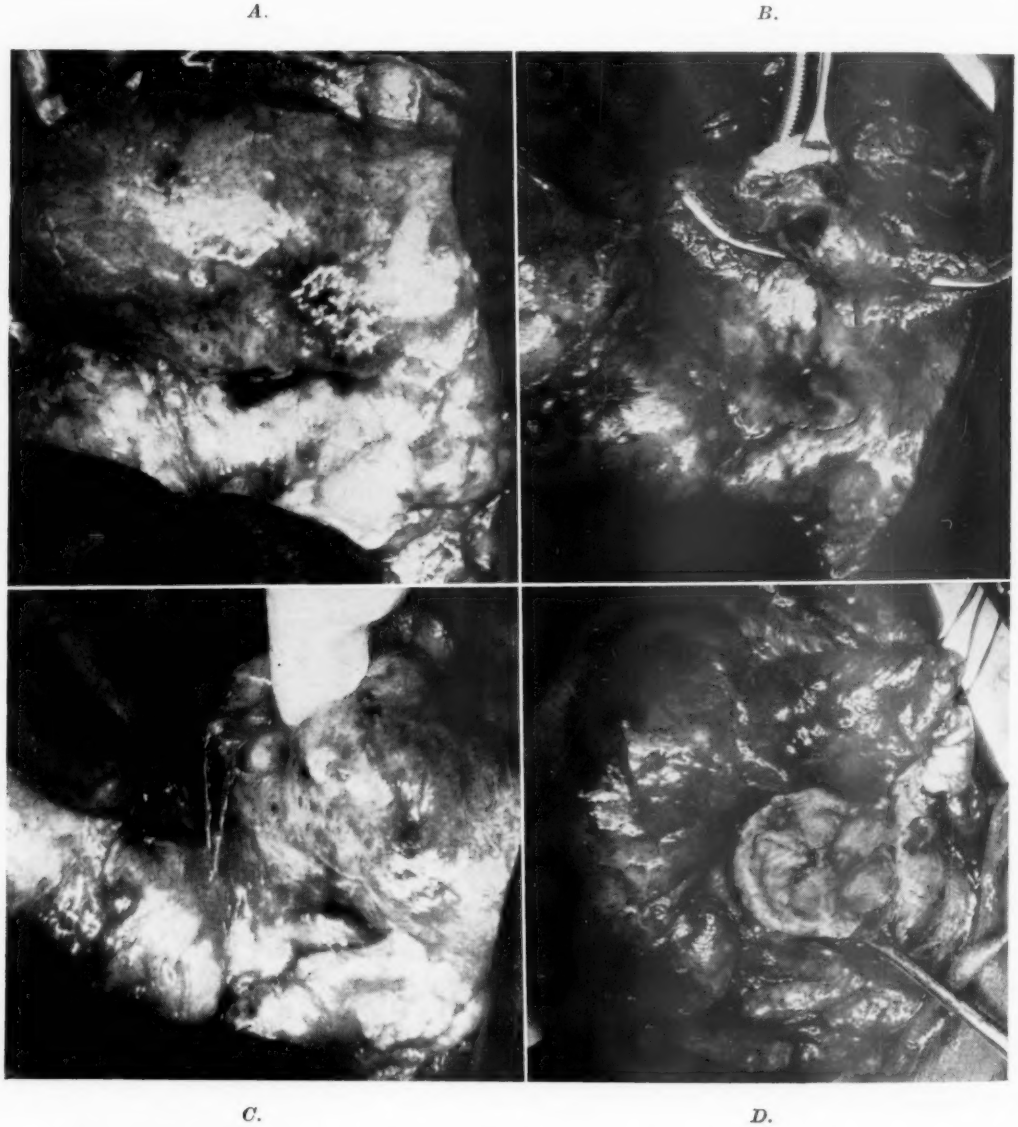


Fig. 10.—*A*, Photograph of pseudoaneurysm arising from left ventricular wall in E. S. after separating many overlying adhesions. Apparently it was made up in large part from the thickened overlying pericardial tissue. *B*, A limited (1 by ½ by 2 cm.) opening is made in an excluded portion of the fundus of the aneurysmal sac, within the confines of a circumscribing purse-string suture. *C*, The operator's ungloved left index finger is inserted through this guarded opening into the aneurysmal chamber. It was determined that there was but a single small passage communicating with the ventricular cavity. The aneurysm was opened wide while finger-tip pressure controlled the ventricular opening. *D*, The ventricular wall has been repaired directly by passing mattress sutures under the tamponading finger.

The postoperative course was smooth except for a bout of atrial fibrillation which responded to quinidine. The outline of the cardiac silhouette returned to a more nearly normal one. The patient continues to do well.

TECHNIQUE OF DIRECT CARDIOANGIOGRAPHY

This procedure is carried out in the Department of Radiology with an anesthetist standing by as a precautionary measure. The patient is brought to the x-ray room in a postabsorbative state after having received 3 grains of secobarbitol one hour before. Fifty milligrams of meperidine are given intramuscularly on arrival.

The equipment required is essentially the same as that used for left heart catheterization with the addition of a rapid multiple exposure camera. In this study, the Sanchez-Perez camera which permits 12 exposures at 2 per second was used. A 6-inch No. 17 thin-walled needle* with a stylet was employed for the left atrial puncture. A fine polyethylene catheter was inserted through the needle for the purpose of obtaining pressure tracings to verify the position of the needle. Recordings were measured by an electromanometer (Sanborn) and recorded on a direct-writing polyoscillograph (Sanborn). Thirty cubic centimeters of 70 per cent Diodrast† were used for opacification.

Our technique for left atrial puncture by the transthoracic route has been described in previous communications.[8, 12, 14] After the patient has assumed the prone position on the fluoroscopic table, his back is prepared and draped for a sterile procedure. The cardiac silhouette is carefully scrutinized by fluoroscopy and the site of needle-entry is selected. This point is 3 to 4 cm. to the right of the midline and usually over the eighth intercostal space. The selection of the intercostal space may vary from 7 to 9 according to the position and the left atrial contour as visualized by fluoroscopy. After infiltration of the site of skin entrance with 2 per cent procaine solution, the needle is inserted, angulated at 15 degrees from the perpendicular in the coronal plane, and advanced. Its course is followed fluoroscopically. As contact is made with the atrial wall, transmitted pulsations are felt through the needle. As pressure is applied to the needle, it first invaginates the wall and finally breaks through with a definite popping sensation. At this point, the catheter is inserted through the needle and a pressure tracing is recorded, establishing the location of the needle tip. Then, the catheter is withdrawn and the stylet is replaced; the needle remains in position through the chest wall. The patient is moved into position over the camera which is located at one end of the fluoroscopic table. The Diodrast is injected manually and rapidly over a 2-second period, using a 50 c.c. syringe and a short length of connecting tubing. A mechanical pump injector is not necessary. Twelve exposures are taken over a 6-second period. Then the needle is removed and the patient is turned into the supine position. Invariably, the patient experiences a hot flush and rapid pulse, both of which subside rapidly.

TECHNIQUE OF SURGICAL REPAIR OF PSEUDOANEURYSM OF LEFT VENTRICLE

The method of repairing the defect in each of these cases was essentially the same.

*Obtainable from Becton-Dickinson Co., Rutherford, N. J.
†Obtainable from Winthrop Laboratories, 1450 Broadway, New York 18, N. Y.

With the patient in the lateral position, the chest was opened along the line of the old incision over the fifth intercostal space, with care being taken to obtain adequate exposure. Then, the adherent lung was dissected off the pulsating mass. A purse-string suture of heavy nylon was placed about a selected portion of the fundus of the aneurysm and incorporated within a Rummel-Belmont tourniquet. A Satinsky clamp was applied to the aneurysmal wall, and the latter was incised within the confines of the purse string. The operator's left index finger was inserted into the aneurysm and the defect in the ventricular wall was explored. In each case, the defect was small enough to be controlled by finger pressure only. Finger-tip tamponade controlled the flow of blood from the ventricular communication in Case No. 2 while the wall of the aneurysm was excised. Then, the defect was controlled by mattress sutures of heavy nylon placed under direct vision. In Case No. 1, there really were two defects so that but one could be controlled by finger pressure at any given time. The wall of the aneurysm formed by the pericardium was sutured to the ventricular surface about the more caudad of the defects as a temporary patch. This was accomplished by a technique similar to that utilized in the treatment of atrial septal defects by atrioseptopexy.[3-5] The aneurysm then was opened widely and under direct vision each defect was repaired individually by appropriate mattress and simple sutures. The patch over the lower defect was removed after the upper was closed by a combination of finger tamponade and undersuturing. Then, it, too, was closed by mattress sutures passed under the tamponading finger tip.

DISCUSSION

The advantages of direct cardioangiography over conventional angiocardiography have been noted by others.[16-18, 21] X-rays of greater detail in outline and sharper in contrast are obtained by injecting radiopaque dye directly into the left side of the heart. The earliest technique of direct cardioangiography was via a transventricular puncture.[16-18] While this approach provides excellent contrast studies of the left ventricle and aorta, it carries with it certain risks not encountered in simple left atrial puncture.[1, 7, 10, 11] The two most formidable risks of the former technique are those of intramyocardial dye injection and injury of a coronary vessel, either of which might result in myocardial infarction. Furthermore, this technique is not considered safe in cases of suspected left ventricular aneurysm since there is always the possibility that the aneurysmal walls might be calcified or extremely thin. The transbronchial approach to the left atrium used originally for left heart catheterization[1, 10] has been suggested by Taufic[22] as suitable for direct cardioangiography. Our familiarity with the transthoracic approach to the left atrium gained from over 450 successful left heart catheterizations has caused us to prefer this method for direct cardioangiography.[8, 12, 14]

The improved contrast and the increased details in the resulting x-rays would seem to make it possible to diagnose with a high degree of accuracy a

variety of lesions including intra-atrial tumors, ventricular septal defects, aneurysm of the ventricle, and aneurysm of the aorta or sinus of Valsalva. Mitral regurgitation can be demonstrated only by direct transventricular injection.[15, 20, 21]

As advances in cardiac surgery are made, techniques are being developed which employ an increasing number of ventricular incisions. Recent improvements in pump oxygenators render feasible the use of wide intraventricular exposures. It seems likely that the incidence of breakdown of ventricular incisions will become more frequent as their utilization and size increase.

It is a surgical dictum that wounds should be placed in a state of rest in order to facilitate rapid and uncomplicated healing. There certainly is no other surgical repair which is subjected to the severe stresses which prevail from the moment of closure of a ventricular incision. The friable quality of the myocardium sometimes found in association with extreme ventricular hypertrophy and heart failure is an additional factor predisposing to an insecure closure. Closure methods must take into account these factors if satisfactory healing is to occur.

The development of cardiac decompensation and the appearance of a previously nonexistent bulge on the cardiac x-ray silhouette in a patient who has had a previous ventricular myotomy strongly suggest the presence of pseudoaneurysm of the ventricle. The radiologic differential diagnosis must be made from pulmonary tumors, localized pericardial effusion, pericardial cyst, aneurysm of the aorta, and especially from a true left ventricular aneurysm.[2, 13] This differentiation may be made readily by direct cardioangiography.

Prolonged observation of these lesions can result only in an increase in their size and the ever-increasing danger of rupture and sudden death. The pathologic physiology of true ventricular aneurysm is severe, and ultimate left ventricular failure is the rule.[19] The size of the aneurysmal sac may be sufficient in some instances to divert 50 to 75 per cent of the cardiac stroke output. As the size of the aneurysm increases, the efficiency of the cardiac output shows a proportional decrease. The left ventricle makes every effort to maintain at least a minimally essential cardiac output, but the lesion is such a devastating one that the usual mechanisms of hypertrophy and dilatation eventually prove inadequate. Intractable left ventricular failure follows. Undoubtedly, pseudoaneurysms must partake of this unfortunate type of cardiac dysfunction at least to some degree.

The relative ease with which this lethal lesion can be relieved justifies surgery as soon as the patient can be prepared adequately.

SUMMARY

1. The possibility of pseudoaneurysm of the ventricle developing following myocardial incisions is suggested. Two corroborative cases are reported.

2. The use of direct cardioangiography in diagnosing this lesion is suggested and the details of this procedure are described.

3. The use of this procedure in the diagnosis of intra-atrial tumor, ventricular septal defect, and ventricular aneurysm has been mentioned.

4. The effectiveness of surgical repair of pseudoaneurysm of the ventricle is stressed and the details of the surgical technique which we have employed are outlined.

5. The consequences of delay and conservative management in this defect would seem usually to be fatal and consist of left ventricular failure and/or rupture of the aneurysm and sudden death.

6. Because of the severe stresses placed upon ventricular incisions, careful and adequate closure of these wounds is mandatory in order to lessen the likelihood of occurrence of this complication.

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CLOSURE OF BRONCHIAL STUMP AFTER PNEUMONECTOMY

Comparison of Some Techniques Through Evaluation of Tensile Strength of Suture

Fábio Schmidt Goffi, M.D., and Ernesto Lima Gonçalves, M.D.,
São Paulo, Brazil

(From the Departamento de Técnica Cirúrgica e Cirurgia Experimental, Faculdade de Medicina da Universidade de São Paulo)

ANATOMIC dissection of the pulmonary pedicle with single treatment of its constituents has caused marked decrease of bronchial stump fistulization post pneumonectomy. Acceptance of general principles on ways of treating the bronchial extremity has also contributed to better statistics on immediate results of pulmonary resection.[7, 14, 15, 16, 19, 21] Thus, bronchial section close to the carina prevents formation of a cul-de-sac that favors secretion storage and enables easier lining of the retracted stumps with protecting structures (mediastinal connective tissue, pleura, and so forth). The use of sutures that do not involve bronchial blood irrigation and careful handling that prevents contamination and air leakage are current proceedings in today's pulmonary surgery.

Notwithstanding these precautions, recent papers[8, 9, 16, 23, 24] show a frequency of bronchopleural fistulas that is not to be overlooked; so the problem of the residual bronchial stump healing is still a momentous subject and further investigations are perfectly justified.

In this series of experiments we have endeavored to study comparatively some technical procedures employed at present for closure of the bronchial stump by measuring the tensile strength of the bronchial suture after pneumonectomy. Tensiometric evaluation of the healing stage of wounds is by no means a new subject. It has been employed by Howes, Sooy, and Harvey[11] in order to study experimentally the rate of wound cicatrization. Since then many papers have been published bearing on the tensile strength of healing of various structures. However, as concerns the bronchial cicatrization process post pneumonectomy, the subject of tensile strength has not as yet been sufficiently studied.

MATERIAL AND METHOD OF STUDY

This study is based upon the analysis of results of 35 left pneumonectomies performed upon apparently healthy adult dogs. The animals were first anesthetized by means of an aqueous solution injected intravenously.*

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*Sodium ethyl 1-methyl-butyl barbiturate, in doses of 0.03 per Kg. animal weight.

Tracheal intubation was then performed in order to maintain respiration by means of an intermittent insufflating apparatus, during the time that the thorax remained open.

Every animal was aseptically operated upon, and the way of approach was that of a left thoracotomy through the fifth intercostal space with no resection of ribs (Fig. 1). Upon opening of the pleural cavity, left pulmonary artery, pulmonary vein, and bronchial vessel ligations were successively performed. The left bronchus was delicately detached up to the carina and sectioned between 2 Mixter clamps set at its juxtapulmonary portion. The lung was thus removed in order to perform reamputation at a higher level and also final bronchial closure.

According to the technique employed for closing the bronchial stump, the animals were divided into 6 groups.

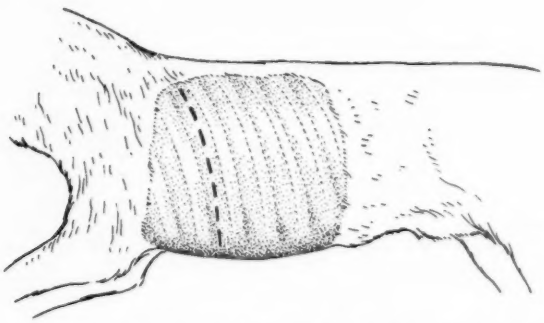


Fig. 1.—Fifth intercostal space thoracotomy.

Group 1.—Mattress suture plus through-and-through end suture were used on 7 animals (Overholt and Langer[16]) (Fig. 2).

After resection of the lung, light traction upon the Mixter clamp revealed the juxtatracheal portion of the bronchial stump; 3 U stitches were placed at the same level just below the carina, corresponding to the cartilaginous ring, each one set at a plane parallel to the bronchus' longitudinal axis. This being done, the bronchus was reamputated with a scissors at a level just below the suture plane, and 4 simple transfixing stitches were placed at the edge of the remaining stump. Necessity of sectioning of the bronchial cartilage has never arisen in regard to Overholt's second technical procedure.

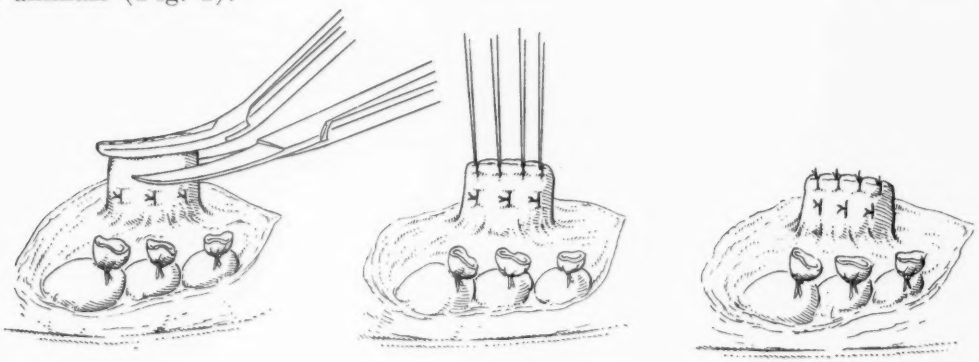
Group 2.—Through-and-through end sutures (Sweet[21]) without pleurization were used in 8 animals (Fig. 3, *A* and *B*).

With a light pull on the Mixter clamp, the bronchus was partially sectioned with scissors in a line parallel to a cartilaginous ring, just below the carina. Closely set transfixing separate stitches were placed through the proximal sectioned edges. By thus performing alternate sections and sutures, reamputation was ended at the same time that 5 or 6 stitches ended the occelusion of the stump.

Group 3.—Through-and-through end sutures followed by pleurization were used in 5 animals(Fig. 3, *A*, *B*, and *C*).

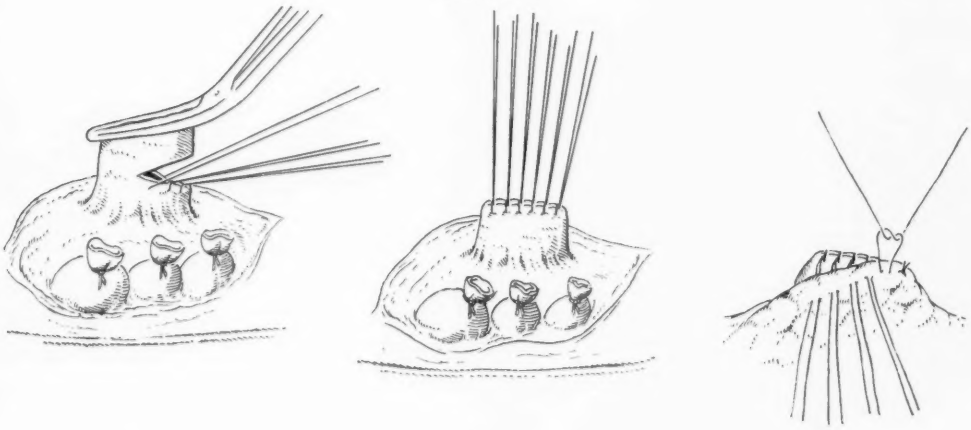
Identical procedure described in Group 2 was utilized. The threads used for suture were afterward passed through one of the mediastinal pleura's edges and tied upon this two to two.

Group 4.—Through-and-through end sutures plus skin graft were used in 5 animals (Fig. 4).



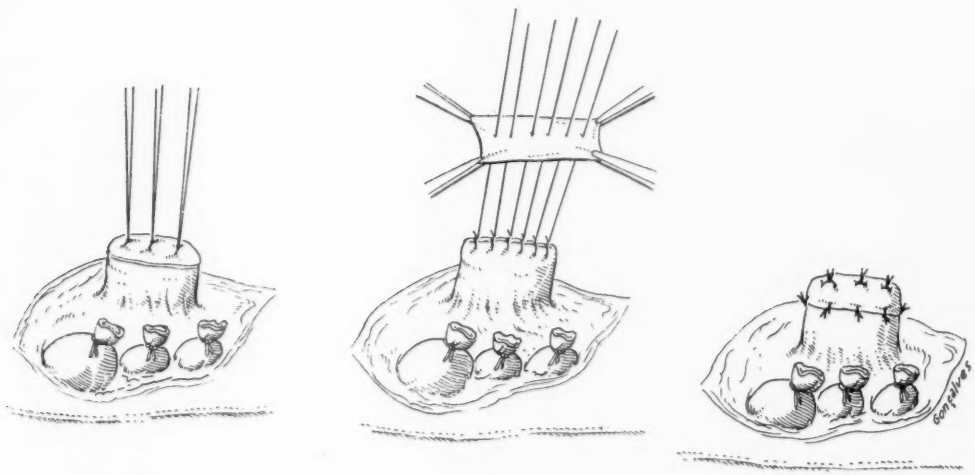
A. *B.* *C.*

Fig. 2.



A. *B.* *C.*

Fig. 3.



A. *B.* *C.*

Fig. 4.

Figs. 2, 3, and 4.—Techniques for closing the bronchial stump.

The same procedure used in Group 2 was adopted. An elliptical skin graft, taken from one of the cutaneous incision edges, was then adapted to the sectioned bronchial extremity. This was obtained by transfixing the graft with the 6 threads utilized for the stump's closure, which were tied two to two upon the graft.

Group 5.—Through-and-through end sutures plus pleuropericardial free graft were used in 5 animals (Fig. 4, *B* and *C*).

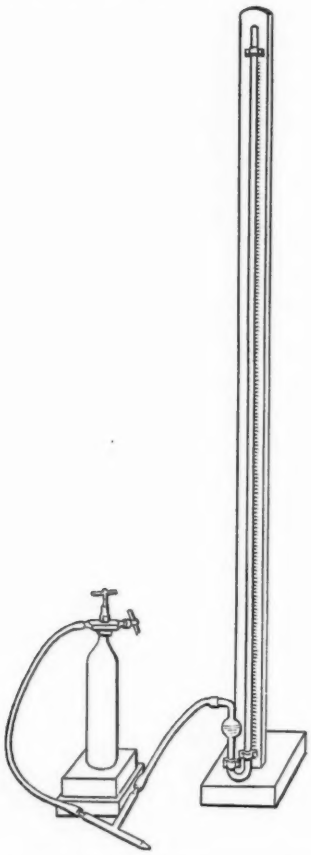


Fig. 5.—Mercury manometer connected with an oxygen cylinder by means of a T tube.

The same procedure used in Group 2 was adopted. The threads used for closing the stump were left separated. An elliptical pleuropericardial free graft was then taken, which was transfixed by means of the afore-mentioned threads. These were then tied, two to two, upon the graft. Interrupted cotton thread stitches were also set, tying the graft's extremities to the peribronchial tissue. The wound made on the pericardial sac was left open.

In all of the 5 afore-mentioned groups, ligations, sutures, and the very bronchial closure were performed with cotton thread. A 3-0 cotton thread was used for the bronchus, set on an Atraumatic curved needle.*

*Anatraum ⅜–3 cm.

Group 6.—Through-and-through end sutures with stainless steel wire were used in 5 animals (Fig. 3, *A*, *B*, and *C*).

The same procedure used in Group 3 was adopted. A stainless steel wire* was used instead of the cotton thread in closing the stump. The resulting stitches were also passed through one of the mediastinal pleura's edges and here tied two to two.

In all animals the closing of the wall was made by layers with separate cotton thread stitches.

Upon completion of the operation, the animals were taken to the kennels, where they were kept in separate cages and were fed their habitual ration, homogenized hospital food remains. After a 7-day period, the animals were killed and a post-mortem examination was performed. The right pulmonary pedicle was dissected and the right bronchus was isolated and firmly clamped. The trachea, isolated at the neck's level, was transversely sectioned, and the distal extremity was connected to one of the branches of a glass T tube, to which it was strongly attached. The other 2 ends of the T tube were connected with a mercury manometer and an oxygen cylinder, respectively (Fig. 5). The cylinder valve was opened slowly and the level in the manometer at which air leakage at the bronchial stump began was jotted down, as well as the one corresponding to rupture by explosion, characterized by sudden fall of the mercury column. None of the operated animals presented spontaneous bronchial fistulization. Post-mortem examination showed sound pleural cavities and perfectly cicatrized left mediastinal pleura.

In order to compare the results thus obtained, the means and its respective standard deviation were determined in each group. These results were then statistically analyzed, the various groups being compared according to the *t* test.[20]

RESULTS AND COMMENTS

The experimental work and clinical observations both show that bronchial stump fistulization incidence is higher around the seventh postoperative day.[14] That is the reason why we chose the seventh postoperative day to evaluate the tissue's tensile resistance.

Explosion pressure in all techniques we studied presented high levels. Nearly all of them were higher than the maximum pressure that is apt to occur in the respiratory tract under normal conditions (Fig. 6). Leakage pressure, nevertheless, presents a marked practical interest, because it is very near values that are apt to be observed in the manometer during the maximum respiratory effort of normal human subjects (Fig. 7). Twenty men, ranging from 22 to 41 years of age, whose histories revealed no respiratory affections, were manometrically tested for maximum of mercury column during sudden expiration effort. Mean value obtained was 20.25 ± 3.42 cm. Hg. Mean leakage and rupture pressures (in cm. Hg) in those 6 groups of dogs studied are listed in Table I.

*Anatraum ⅜–3 cm.

TABLE I

GROUP	MEAN BODY WEIGHT (KG.)	MEAN LEAKAGE PRESSURE	MEAN RUPTURE PRESSURE
1	12.2	18.25 ± 6.99	48.28 ± 19.37
2	11.3	22.66 ± 2.61	47.28 ± 16.35
3	11.4	29.80 ± 1.09	89.6 ± 34.03
4	11.2	24.2 ± 5.51	50.8 ± 8.43
5	12.0	48.2 ± 14.4	99.0 ± 18.4
6	11.4	42.2 ± 26.2	74.33 ± 18.8

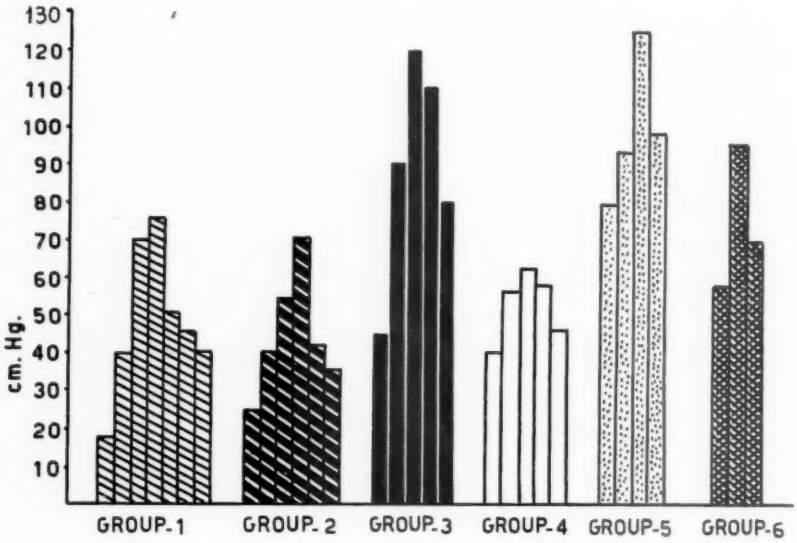


Fig. 6.—Rupture pressure.

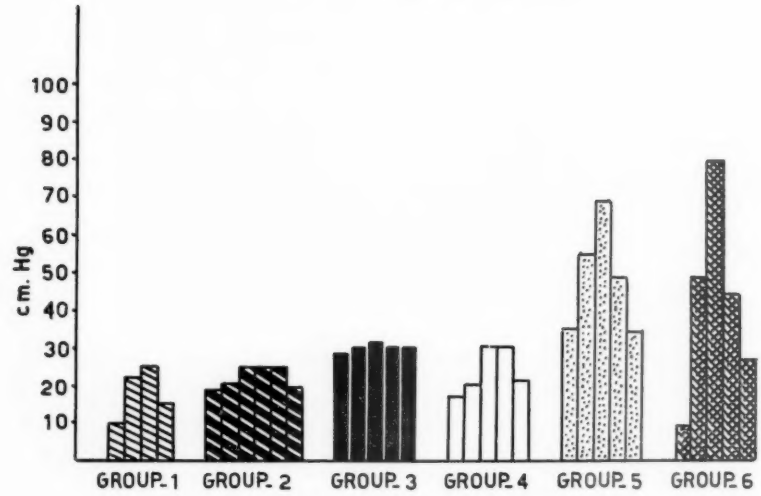


Fig. 7.—Leakage pressure.

One must take into account the importance of hypoproteinemia, lack of ascorbic acid, infection, or else chance damages to blood supply of bronchi in determining opening of suture. Whatever their respective roles, together or taken one at a time, tracheal hypertension will always be the determining

factor. Air leakage at the suture, during violent expiratory efforts, might be held responsible for transmitting the bronchus' septic contents to the mediastinum. This is apt to result in contamination, infection, and opening of the stump.

In order to verify the relative value of the technical variations employed in the closure of the bronchial stump, we tested the hypothesis of homogeneity of the means of leakage and explosion pressures, respectively, in the 6 groups studied (Tables II and III).

TABLE II. SIGNIFICANCE TEST OF THE MEAN LEAKAGE PRESSURES

GROUPS	MEANS (CM. HG)	NUMBER OF ITEMS	t	$t_{0.05}$
1	18.25	4		
and				
2	22.66	6	1.440	2.306
2	22.66	6		
and			5.758	2.262
3	29.80	5		
2	22.66	6		
and			0.614	2.262
4	24.2	5		
3	29.80	5		
and			2.762	2.306
5	48.2	5		
3	29.80	5		
and			1.057	2.306
6	42.2	5		

TABLE III. RUPTURE PRESSURES

GROUPS	MEANS (CM. HG)	NUMBER OF ITEMS	t	$t_{0.05}$
1	48.28	7		
and			0.115	2.201
2	47.28	6		
2	47.28	6		
and			3.066	2.262
3	89.6	5		
2	47.28	6		
and			0.437	2.262
4	50.8	5		
3	89.6	5		
and			0.574	2.262
5	99.0	4		
3	89.6	5		
and			0.825	2.306
6	74.33	3		

Comparison was first made between Groups 1 and 2, mattress suture plus through-and-through and simple through-and-through end suture without employing pleura to line the bronchial extremity. Leakage pressure means showed $t = 1.440$, and explosion pressure means showed $t = 0.115$. These values are not significant at the level of 0.05, with 8 and 11 degrees of freedom,

respectively. This means that the techniques do not differ essentially when studied in regard to the suture tensile resistance around the seventh postoperative day.

Overholt and Langer,[16] commenting upon bronchial closure technique, state that the U stitches set at a level just above the sectioned edges are intended to prevent action of excessive endotracheal pressure during coughing effort upon the cicatrization process of the extremity. However, we think that these stitches, besides being useless, demand a longer bronchial segment for them to be set. This goes against the established principle of cutting the bronchus close to the carina. Animals upon which this operating technique was performed presented rupture almost always at the site of the mattress stitches that cut through the entire thickness of the bronchial wall.

Comparison was also made between Groups 2 and 3, through-and-through end suture with and without pleurization. The following values were found: $t = 5.758$ for leakage pressure and $t = 3.066$ for explosion pressure. Both values are significant at the level of 0.05, with a 9-degree freedom, which is to say that the utilization of pleura to line the suture bronchial extremity gives the healing tissue a noticeable tensile strength. It has been known for a long time that the serous membranes are capable of making sutures airtight. The importance of the pleura as a protection for the bronchial stump had already been suspected by Heuer and Dunn.[10] Rienhoff and co-workers[19] bear the merit of having exhaustively studied this subject, proving experimentally the effectiveness of a pleural lining of the bronchial stump. This procedure is adopted today by the great majority of surgeons. However, the search for a radical surgical procedure in the treatment of malignant pulmonary tumors has evolved a new difficulty. Larger resections of the mediastinal pleura become necessary, followed by careful lymph node removal.[4, 5] This limits, perhaps even totally prevents, the use of pleural flaps for lining the bronchial stump. Free pleuropulmonary grafts have been suggested as substitutes, taken from the resected piece,[6, 13] as well as pieces of pericardial fat,[3] muscle sections,[22] epiploon grafts,[14] aponeurotic segment of the musculus serratus anterior,[2] and free skin grafts.[18]

The value of autogenous total skin grafts as a protecting means for the bronchial extremity after pneumonectomy was studied. Good grafting was noticed histologically, well united to the surface of the sectioned bronchus. Between cartilage and graft there was a thin sheet of young connective tissue. Results of the group in which the bronchial stump was reinforced with a total skin graft were compared with those in which no pleurization technique was employed. Statistical analysis showed t values not significant at the level of 0.05 with a 9-degree freedom (respectively, 0.614 and 0.437). The modification of procedure for cutaneous graft, be it through thin or intermediate transplants instead of total skin or be it through a different technique when it is being attached to the bronchial extremity, perhaps might give better results.

Grafting of an autogenous pleuropericardial segment to the bronchial stump was also attempted. Comparing the results obtained in this group with

those obtained in the group where the stump was lined by means of the edges of the mediastinal pleura, the following was found: for leakage pressures $t = 2.762$ and for explosion pressures $t = 0.574$. The first value of t is significant at the level of 0.05, with an 8-degree freedom, that is to say the lining of the bronchial stump with a pleuropericardial free graft has a noticeably reinforcing effect upon the structure, decreasing the possibility of opening.

The influence of the suture material upon the bronchial stump resistance was finally studied. In one group of dogs cotton thread was used, and in another group stainless steel wire was employed. Since Babcock's work,[1] many have tried steel wire in surgery. As concerns the bronchi, Overholt and Langer[16] recommend steel wire for their closing in the presence of pulmonary tuberculosis. Jones[12] follows the same procedure.

Comparison was made between those 2 groups where Sweet's technique with pleurization of bronchial extremity was employed; one group used cotton and the other steel wire for suture. Values obtained were as follows: for leakage pressures $t = 1.057$, and for explosion pressures $t = 0.825$. These values of t are not significant at the level of 0.05, with 8 and 6 degrees of freedom, respectively. This means that the nature of suture material employed in closing the bronchial stump does not interfere with results.

CONCLUSIONS

1. Mean leakage pressures presented values near those that may occur in the respiratory tree of normal human adults during sudden respiratory efforts.

2. Mattress suture plus through-and-through end suture and single through-and-through end suture, when compared as to the endotracheal pressures necessary for causing leakage and rupture of the bronchial stump by explosion, do not differ significantly.

3. The use of mediastinal pleura for lining the sutured bronchial extremity gives the healing tissue a marked tensile strength.

4. The use of free skin grafts for protection of the bronchial stump does not give a significant increase of the tensile strength of the suture.

5. Lining the bronchial stump with a free pleuropericardial graft markedly reinforces the suture, as concerns the necessary endotracheal pressure in order to cause leakage through the stump. There is no significant difference where rupture pressure is concerned.

6. There is no significant difference between leakage and rupture pressure values obtained by using either cotton or stainless steel wire to close the bronchial stump.

SUMMARY

An experimental study on the technique of closure of the bronchial stump was carried on in adult mongrel dogs measuring the tensile strength of the suture.

Technical points are discussed and results are presented.

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LUNG RESECTION FOR METASTATIC CANCER

29 Cases From the University of Minnesota and a Collected Review of 264 Cases

Marvin L. Gliedman, M.D.,* Samuel Horowitz, M.D., and
F. John Lewis, M.D.,** Minneapolis, Minn.

(From the Department of Surgery, University of Minnesota)

INTRODUCTION

SURGEONS who treat patients with visceral cancer should, in certain situations, consider the advisability of excising metastases which were once thought of as hopeless. Residual, regional, lymphatic metastases have been successfully eradicated in some cases by "second look" operations.[80] Blood-borne metastases are probably less suitable. Liver metastases, for example, have not yet been excised with lasting success. Still, even more distant blood-borne metastases, those to the lungs, can occasionally be successfully extirpated.

There are several reasons why lung metastases may be amenable to surgical excision. First, they can be detected through roentgen examination while still small and resectable with a high degree of accuracy. Then, once they have been discovered, they can be removed by good, widely employed techniques for excising segments or wedges of the lung tissue. If indicated, multiple operations and bilateral excisions can be carried out. Finally, this type of surgery can be done with a low mortality rate even in relatively poor-risk patients.

The evidence presented in this paper, which includes a collective review of 264 cases as well as the 29 cases done at the University of Minnesota shows that excision of lung metastases has been beneficial in a significant number of patients. Long-term survival as well as worth-while palliation has occurred more frequently than might have been expected.

Some points concerning the handling of the data should be mentioned. Cases in which the primary cancer was found only at autopsy or not identified were not knowingly included. For ease of analysis, the cases were divided into the following categories with regard to the ultimate result of therapy: insufficient information; postoperative deaths; and survival for more than 1, 2, 3, 4, or 5 years after lung resection. In the cases reviewed from the literature those reported with interval to time of death after lung resection were considered in categories appropriate to the interval of time. Thus a patient who died at 14 months after lung surgery was considered alive over one year. All cases with short follow-ups or insufficient information were considered to be "dead" beyond the last reported date. The survival interval was plotted from the time

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*Dr. Gliedman is now in the United States Navy, St. Albans Hospital, New York.

**Dr. Lewis is now in the Department of Surgery, Northwestern University Medical School, Chicago.

of the last lung resection if multiple procedures were carried out. The cases from the University of Minnesota Hospitals will be considered first but they are also included in the collected series.

UNIVERSITY OF MINNESOTA CASES

Clinical Material.—The 29 patients in this series were operated upon from 1944 through 1954. There were 18 carcinomas and 11 sarcomas with a considerable variety in pathology (Table I). Seventeen of the patients were men and 12 were women. The average age of the men was 40.4 years and of the women 49 years, a younger average age than that noted in most groups of cancer patients.

TABLE IA. LUNG RESECTIONS FOR METASTATIC CARCINOMA
(University of Minnesota)

PRIMARY TUMOR	NUMBER OF PATIENTS	PRESENT STATUS: LENGTH OF SURVIVAL FOLLOWING LUNG RESECTION				
		LESS THAN 6 MONTHS	6 MONTHS TO 1 YEAR	1 TO 3 YEARS	3 TO 5 YEARS	OVER 5 YEARS
Kidney—7						
Clear cell carcinoma	1			X		
Wilms's tumor	1				O	
Hypernephroma	5	X	X	X, O	X	
Adrenal	1			X		
Gastrointestinal—3						
Stomach	1				O	
Splenic flexure	1					O
Rectum	1			O		
Malignant melanoma	2		X	O		
Cervix	2		X	X		
Adenocarcinoma of bladder	1		X			
Squamous carcinoma of ear	1			O		
Cylindroma of sublingual gland	1			O		
Total	18					

O = Living.
X = Dead.

TABLE IB. LUNG RESECTIONS FOR METASTATIC SARCOMA
(University of Minnesota)

PRIMARY TUMOR	NUMBER OF PATIENTS	PRESENT STATUS: LENGTH OF SURVIVAL FOLLOWING LUNG RESECTION				
		LESS THAN 6 MONTHS	6 MONTHS TO 1 YEAR	1 TO 3 YEARS	3 TO 5 YEARS	OVER 5
Fibrosarcoma—4						
Occiput	1				O	
Mediastinum	1			X		
Quadriceps	1	X				
Breast	1	X				
Osteogenic sarcoma—4						
Tibia	1		X			
Femur	1		X			
Fibula	1		X			
Humerus	1		X			
Periosteal sarcoma (femur)	1			X		
Ewing's sarcoma (tibia)	1		O			
Synovioma (hand)	1					X
Total	11					

O = Living.
X = Dead.

A simple nodulectomy or wedge excision was the commonest resection, though all types of lung resection were employed. In total, 43 lung resections were done with 29 nodulectomies, 15 lobectomies, 5 pneumonectomies, 2 segmental resections, and 2 biopsies. Multiple and mixed procedures account for the disparity in totals.

Resections or explorations were done in a number of cases where the chances of success were small. In fact, 16 (55 per cent) of the 29 cases were found to have multiple lung metastases and in 6 of these cases gross tumor was left at the time of surgery.

Results.—The survival data for the University of Minnesota cases are detailed in Table II and summarized in Tables I and III. In Table III, the percentage figures do not represent conventional 3- and 5-year survival rates but merely the percentage of the total group of 29 patients who had reached these survival times. The number of patients who had their lung resections more than 5 years ago is small but there appears to have been a significant salvage among them. Nine patients had their pulmonary operation over 5 years ago and 2 (22 per cent) survived 5 years. Furthermore, 6 (40 per cent) of the 15 patients operated upon more than 3 years ago were 3-year survivors. In the entire group there was only one operative death.

In general the results among these patients have been surprisingly good. If only the patients who were thought to have complete removal of the lung lesions at the time of surgery are considered, 17 of 23 (74 per cent) survived over one year. The survival was somewhat better for patients with carcinomas than for those with sarcomas. Four of the six 3-year survivors had carcinomas, and one of the two 5-year survivors had a carcinoma. Even among patients that have needed resections for multiple metastases there may have been significant palliation. One case, an Ewing's sarcoma of the tibia, had 7 separate lung resections over an 8-year period before his disease finally became nonresectable in June, 1955. He has survived 12 years since the primary resection but since only the time from the last resection has been considered in the survival summary, he falls into the group alive under one year. Two other cases in which multiple metastases were resected at one operation have had particularly favorable results. They are found among the 6 cases who survived for 3 years.

There was no apparent correlation in this group between the ultimate length of survival and the interval of time between the primary operation and the date when the lung metastases were discovered.

The 6 cases in which resection was obviously incomplete deserve separate consideration. It is not surprising that only 2 among the 6 patients survived beyond one year. One of these lived 2 years after the lung surgery and the other patient is still alive at the present time, 1½ years after her lung resection. More surprising is the fact that this last patient no longer has x-ray evidence of metastases. She had bilateral lung metastases demonstrated by x-ray at the time her primary hypernephroma was resected. Following extirpation of the primary, the lung metastases in the right lung field apparently disappeared.

TABLE II. SUMMARY OF UNIVERSITY OF MINNESOTA CASES

CASE	PRIMARY MALIGNANCY	INTERVAL TO DISCOVERY OF METASTASES (MONTHS)	TYPE OF LUNG RESECTION	OUTCOME: MONTHS AFTER LUNG RESECTION		
				ALIVE AND WELL	ALIVE WITH RECURRENCE	DEAD
1	Hypernephroma	Lung lesion before primary	Segmental and wedge			43
2	Hypernephroma	28	a. Wedge b. Pneumonectomy			32
3	Hypernephroma	0	Lobectomy (incomplete)	16		
4	Hypernephroma	12	Lobectomy			0
5	Hypernephroma	48	Lobectomy (incomplete)			11
6	Carcinoma of kidney	8	Wedge			12
7	Wilms's tumor	7	Wedge	42		
8	Carcinoma of adrenal	21	Wedge			13
9	Carcinoma of stomach	20	Wedge	43		
10	Carcinoma of colon	46	Pneumonectomy	60		
11	Carcinoma of rectum	36	Wedge	24		
12	Malignant melanoma of forearm	15	Wedge			6
13	Malignant melanoma of forearm	52	Segmental	15		
14	Carcinoma cervix (squamous cell)	72	Wedge			14
15	Carcinoma cervix (squamous cell)	23	Pneumonectomy (incomplete)			10
16	Carcinoma bladder	30	Wedge and lobectomy			11
17	Squamous cell carcinoma	12	Wedge	16		
18	Cylindroma sublingual gland	Lung nodules first	Wedge	26		
19	Fibrosarcoma occipital region	0	Wedge	38		
20	Fibrosarcoma mediastinum	4	Pneumonectomy			25
21	Fibrosarcoma quadriceps	22	a. Wedge b. Lobectomy c. Lobectomy			4
22	Fibrosarcoma breast	48	Lobectomy			5
23	Osteogenic sarcoma tibia	16	Pneumonectomy			12
24	Osteogenic sarcoma femur	13	a. Lobectomy b. Biopsy			7
25	Osteogenic sarcoma fibula	10	a. Wedge b. Incomplete resection			6
26	Osteogenic sarcoma humerus	17	Wedge and lobectomy			11
27	Periosteal fibrosarcoma femur	10	a. Wedge b. Wedge			14
28	Ewing's sarcoma tibia	25	7 lung resections in 8 yrs.		11	
29	Synovioma hand	264	Lobectomy			96

TABLE III. LENGTH OF SURVIVAL FOLLOWING LAST LUNG RESECTION IN 29 PATIENTS (University of Minnesota Series)

SURVIVAL OVER	NUMBER OF PATIENTS
1 year	17 (58.6%)
2 years	9 (39.1%)
3 years	6 (20.6%)
5 years	2 (6.9%)

The patient was followed for 3 years while the lesions in the left lung and hilum grew slowly in size until respiratory symptoms developed. A lobectomy was then performed to remove the metastases in the left lung. Unfortunately, the hilar region was extensively infiltrated, and tumor was transected while doing the lobectomy. Chest x-rays 4 months after lung surgery again revealed the right lung metastases which had supposedly disappeared 3½ years previously, but chest x-rays 16 months after the lung surgery no longer revealed obvious lung metastases in either the right or left lung fields!

REVIEW OF CASES COLLECTED FROM THE LITERATURE

As might be expected, these collected cases[1-79, 81-84] were described in varying detail so that complete data are not available concerning all the cases. In all cases, however, the primary lesion was resected, but in 4 no other details were mentioned except that metastatic lung nodules had been resected. These 4 cases are included in the over-all total, but since they could not be used for any other analysis, we are left with 260 cases. The sarcomas and carcinomas were considered separately, and the carcinomas were further subdivided according to the organ of the primary if the subgroup appeared to be large enough.

Metastatic Carcinoma.—

Clinical material: The carcinomas form the biggest group with 191 cases. They are further subdivided in Table IV, according to location of the primary. While in many cases it was not possible to determine whether the lesion was multiple or solitary, in 53 cases (27 per cent) sufficient information was given to indicate that the lesion was multiple at the time of the lung resection.

TABLE IV. REPORTED SURVIVAL OF RESECTED METASTATIC LUNG CANCER

PRIMARY SITE	NUMBER OF PATIENTS	PATIENTS SURVIVING				
		1 YEAR AND OVER	2 YEARS AND OVER	3 YEARS AND OVER	4 YEARS AND OVER	5 YEARS AND OVER
Carcinomas:						
Gastro-intestinal-colonic	45	20	11	6	3	1
Malignant melanoma	19	5	0	0	0	0
Male gonodal	11	3	2	1	0	0
Female gonodal	10	7	3	2	1	1
Breast	14	6	2	2	1	1
Kidney	37	15	11	5	3	3
Uterine	30	12	7	5	2	1
Miscellaneous	25	12	3	1	1	1
Total carcinomas	191	80	39	22	11	8
Per cent	100%	41.8%	20.2%	11.5%	5.7%	4.2%
Total sarcoma	69	32	22	15	10	10
Per cent	100%	46%	32%	22%	15%	15%

Results: A summary of the reported length of survival is also tabulated in Table IV. As may be seen, 41 per cent of the patients with metastatic carcinoma were reported as having survived one year or more, and 4.2 per cent had survived beyond 5 years at the time of the report. It should be pointed out that this is not a true 5-year survival rate; though a 5-year survival rate cannot be obtained from these data, it would doubtless be higher than this figure.

An attempt was made to compare the length of survival with the interval of time between the resection of the primary and the discovery of the metastases, but the small number of cases that fell into each subgroup, as well as the great individual differences in length of survival, made analysis difficult. Nonetheless, those patients who had their metastases and the primary tumor discovered simultaneously and those patients in whom the lung lesion was found within one year of the primary resection fall into an unfavorable group. In rather surprising contrast, the 5 patients who had had a lung resection before the primary was discovered had an unexpectedly favorable outcome. These cases have the longest average reported survival. It is possible, of course, that such cases were more apt to be reported because of their striking nature, and, in any case, their number is too small for discrete analysis.

The operative procedures used in treating these metastases may be summarized as follows: lobectomy was used 73 times; pneumonectomy 49 times; segmental resection 10 times; and nodulectomy or wedge resection 21 times. In contrast to this general experience, it will be remembered that a nodulectomy was the commonest operation in the University of Minnesota series. There were not enough cases to prove that one type of resection was better than the others, but the figures seem to favor the bigger resections. Of the 8 cases reported as living 5 years or longer, 4 had pneumonectomies and 4 had lobectomies. Of course, this may only illustrate that fewer segmental resections were done prior to 5 years ago.

The length of survival reported from the time of the first sign of cancer is shown in Table V. Again these figures are not conventional survival rates based on all the operations done prior to 3, 4, or 5 years ago, but merely a tabulation of the number of patients who had survived the length of time indicated when the author made his report. Percentages are based on the total number of patients in either the carcinoma or sarcoma group. The number of long-term survivors in this table is impressive. This is partially due to the fact that a number of patients had already exceeded a 5-year survival before their pulmonary metastases appeared, indicating that the lesions were of a slow-growing type. It is encouraging, nonetheless, to note that over 43 per cent had survived 5 years from the first sign of cancer.

TABLE V. TOTAL SURVIVAL FROM DISCOVERY OF FIRST SIGN OF CANCER

TYPE OF CANCER	PATIENTS SURVIVING				
	OVER 1 YEAR	OVER 2 YEARS	OVER 3 YEARS	OVER 4 YEARS	OVER 5 YEARS
Carcinoma	171 (89.5%)	145 (76.0%)	125 (65.5%)	99 (51.8%)	83 (43.4%)
Sarcoma	59 (85.5%)	47 (67.2%)	38 (55.0%)	32 (46.4%)	28 (40.5%)

Metastatic Sarcoma.—

The reported length of survival among the 69 cases of sarcoma reviewed is shown in Table IV. There was considerable pathologic variety in the primary tumors, but the subgroups were all small and so all of the sarcomas have been considered as a single group. Again, as in the group with carcinoma, it has

been difficult to reach a conclusion concerning the significance of the time interval between the primary operation and the discovery of metastases, but there appears to be no significant correlation.

The 10 patients (15 per cent of the total group of sarcomas) who had survived 5 years following lung surgery, at the time the author wrote his report, are listed in Table VI. They are a varied group, but 3 of the patients had osteogenic sarcoma, a type of tumor usually associated with a poor prognosis. In the collected data results are apparently better among those patients with sarcomas than among the patients with metastatic carcinomas. At least 19 cases (27.1 per cent) had multiple lesions, but as in the carcinomas, this did not signify a hopeless situation. Two of the 10 cases that survived beyond 5 years actually had multiple metastases.

TABLE VI. FIVE-YEAR SURVIVAL OF METASTATIC SARCOMAS

AUTHOR	TYPE	REMARKS
Von Hazel[77]	Sarcoma—no further information	Alive 9 years after lung surgery, with recurrence
Kergin[40]	Fibrosarcoma of thigh	Alive and well 6 years 6 months after lung resection
Sweet[73]	Sarcoma of breast	Alive and well 7 years after lung resection
Von Hazel[77]	Osteogenic sarcoma of leg	Alive and well 9 years after lung resection
Goldenberg[31]	Osteogenic sarcoma of tibia	Alive and well 8 years after lung resection
Alexander, Eschapasse[2]	Myogenic sarcoma of thigh	Alive and well 6 years 9 months after lung resection
Alexander, Eschapasse[2]	Neurogenic sarcoma of median nerve	Alive and well 8 years 1 month after second lung resection
Higginson[34]	Fibrosarcoma of right thigh	Alive 6 years 2 months, with unresectable metastases
Kronlein[41]	Osteogenic sarcoma of rib	Died 6 years after lung resection, with recurrence of primary
University of Minnesota	Synovioma of hand	Had 12 operations for primary; died 8 years after lung surgery

The operative procedures used were: lobectomy, 33 times; pneumonectomies, 16 times; wedge or nodulectomy, 11 times; and segmental resections, 4 times. In 7 of the 10 patients reported to have survived beyond 5 years, information concerning the type of resection was available; 5 of these patients had lobectomies, and 2 had pneumonectomies.

For the sarcomas, the length of survival from the first recognition of the cancer is tabulated in Table V. As in the carcinomas, a significant proportion of the group had survived over 5 years at the time of the report.

DISCUSSION

Early reporting of many cases with no follow-up study makes critical analysis of the data accumulated from the literature inconclusive. Because

many cases were reported as alive but at a very early postoperative period, the analytic figures could be considerably changed by an eventual follow-up on these patients. This type of surgery has been used only recently and better follow-up studies will come in time. At present, the summary data concerning the collected cases is not comparable to the conventional and more useful 3- and 5-year survival rates. Nevertheless, the data, as presented, is sufficient to allow some inferences.

From the collected data, metastatic sarcoma appears to have a better outlook than carcinoma (15 per cent of the sarcoma cases are reported as having survived 5 years, as contrasted to 4.2 per cent for the carcinomas).

With 25 per cent, at least, of the lung lesions turning out to be multiple, the concept of resecting only solitary lung metastases is unrealistic. The patient with multiple metastases must be assessed with the ideal of removing all the possible tumor and yet still not resecting so much lung parenchyma that he is made a pulmonary cripple. This same patient may again, at a later date, show additional lung metastases which could still be resected. Small resections, nodulectomies or wedge resections, which remove the tumor but not much normal parenchyma should be the procedure of choice, but since these operations have not yet resulted in long-term survivors, the point is not settled. It may actually be that a lobectomy offers better hope of satisfactorily removing the tumor in suitable cases.

Many of the patients that responded well to surgical treatment doubtless had slow growing tumors and it is possible that their ultimate prognosis would have been as good without surgery. Unfortunately, there is no satisfactory control group made up of patients who did not have pulmonary resections. The nearest thing to a control is a small group of patients who had thoracotomy but only a biopsy of the metastases. Often the final results for these patients were not reported, but 18 of the cases reviewed fall into this group and can be considered. Of these, only one was reported as surviving as long as 2 years, and 12 had died after one year or less. One notable exception to the unfavorable course which typifies the group was the patient with a hypernephroma and bilateral metastases discussed under the University of Minnesota series (Case No. 3). Two patients were reported as being alive at 2 and 6 months, respectively, following the thoractotomy, and there was no follow-up reported for 2. In summary, 11 per cent of this special subgroup survived one year or more, and an additional 11 per cent were reported as being alive under one year following surgery. These values are considerably below the over-all averages.

The poor prognosis of the early appearing metastases (under one year) may represent the activation of small lung metastases, already present, by the operation which removed the primary tumor, or it may merely represent the end stage of virulent growth. The poor survival of the group in which the metastases were discovered simultaneously with the primary tumor as opposed to the good results among those patients in which the metastatic lesions were resected first is surprising, but this might suggest that poor survival in the first group could again be due to activation of metastases by resection of the primary.

The good results obtained in the few cases where the metastases were resected first could conceivably be because the area sensitive to activation by the primary tumor was resected before removing the parent tumor. This concept is, of course, highly speculative for the number of cases was small and numerous factors are certain to play a part in governing the ultimate outcome among such patients.

While some information which should be valuable in selecting cases has been derived from the data, it must be emphasized that long-term salvage was possible in almost every group and against every proposed criteria to determine salvageability. The procedure of removing metastatic lung lesions can be viewed either as a palliative operation or an attempt at ultimate cure. Patients were relieved from incapacitating respiratory complaints by surgery; this cannot be minimized, for respiratory symptoms are a prominent difficulty in patients with metastatic pulmonary lung lesions. In addition, some patients may actually have achieved a cure. That 15 per cent of the patients undergoing resections for metastatic sarcoma are reported as surviving 5 years or more is clearly significant. Furthermore, there is still one other reason for recommending resection of lung lesions that are apparently metastatic; some of these tumors actually turn out to be primary lung cancers.

SUMMARY

1. Twenty-nine patients who underwent resection of metastatic lung lesions at the University of Minnesota Hospitals are reported and reviewed.

2. These are combined with the cases reported in the literature to make a total of 264 cases for a collected review.

3. In this total group, 3.7 per cent of the patients who had resections for metastatic carcinoma were reported as having survived 5 years or more, and 15 per cent of those who had metastatic sarcomas had survived 5 years or more at the time the authors made their reports.

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ADDENDUM

Since our preparation of the manuscript 62 additional cases, sufficiently detailed to be analyzed and fulfilling the criteria of this study, have been published.* Forty-eight of these patients had carcinomas as primary lesions; 14 patients had metastases from sarcomas. The reported survival following resections of lung metastases from sarcomas was 12.0 per cent; following resection of lung metastases from carcinoma the survival was 5.0 per cent. The results including the additional cases are tabled below.

	NUMBER OF PATIENTS	PATIENTS SURVIVING				
		1 YEAR AND OVER	2 YEARS AND OVER	3 YEARS AND OVER	4 YEARS AND OVER	5 YEARS AND OVER
Total carcinomas	239	101	49	29	18	12
Per cent	100	42.3	20.5	12.1	7.5	5.0
Total sarcomas	83	40	25	16	10	10
Per cent	100	48.2	30.1	19.3	12.0	12.0

The primary malignancies in the 5 additional 5-year survivors were in 2 patients with carcinoma of the kidney, in one with carcinoma of the rectum, in one with carcinoma of the uterus, and in one with carcinoma of the bladder. They were treated by lobectomy in 4 instances and once by pneumonectomy.

An attempt was again made to compare the length of survival with the interval of time between the primary resection and the discovery of the metastasis. The results, as before, showed no significant correlation.

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A HISTOLOGIC STUDY OF ROUTINE SCALENE NODE BIOPSIES

HARRY SCHWIPPERT, M.D.,* AND JOSEPH E. MACMANUS, M.D.,** BUFFALO, N. Y.

(From the Thoracic Surgical Service of the Roswell Park Memorial Institute and the Department of Surgery, University of Buffalo Medical School)

IN 1955, the Thoracic Surgical Service of the Roswell Park Memorial Institute inaugurated a histologic study of routine scalene node biopsy material taken from patients attending the Thoracic Surgery Clinic who were suspected of pulmonary malignancy but who were free of palpable cervical node pathology. The objects of this investigation included a study of the frequency of scalene node metastasis in proved bronchogenic carcinoma, an evaluation of the procedure as a diagnostic tool in the study of intrathoracic disease other than bronchogenic carcinoma, and an estimation of the frequency of a positive scalene node biopsy in a clinically suspected case of carcinoma of the lung when all other studies were negative.

DEFINITION AND MATERIAL

The term scalene node biopsy, as we use it, implies the surgical exploration of the anterior scalene region and the removal of the scalene fat pad and lymph nodes in toto. The case material was drawn from those patients entering the Thoracic Surgical Service of the Roswell Park Institute from February, 1955, to Aug. 1, 1956, upon whom some method of treatment was followed, either surgical, radiologic, or chemotherapeutic. This included those cases in which the diagnosis of carcinoma was originally suspected but subsequent investigations, including the scalene node biopsy, disclosed that the diagnosis of carcinoma was incorrect. Scalene node biopsies were not done, however, on patients who presented lesions which were thought to be clearly benign in nature (mediastinal cysts, dermoid cysts, and bronchogenic cysts). Occasionally a patient was seen in the clinic who, because of marked debility or metastatic disease, was thought to be in the advanced terminal stages of disease where the diagnosis seemed clear and little or no purpose would be served by studying the patient further with a scalene node biopsy. These patients were excluded from this study.

THE SELECTION OF THE SIDE FOR THE BIOPSY

Routine bilateral scalene node dissections were not done. The side selected for the scalene node biopsy followed the general plan of Rouviere's[3] description of lymph node drainage from the thoracic wall and lungs. In

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*Associate Cancer Research Thoracic Surgeon, Roswell Park Memorial Institute.

**Consultant in Thoracic Surgery, Roswell Park Memorial Institute, and Associate Clinical Professor of Surgery, University of Buffalo Medical School.

patients with left upper lobe lesions, the left scalene pad was removed. In those with left lower lobe lesions or right-sided lesions irrespective of their position, the biopsy was taken from the right.

METHOD

The method used for this study was similar to that described by Connar.[1] Under local anesthesia a transverse incision was made over the lateral border of the sternocleidomastoid muscle about an inch above the clavicle. Dissection was carried down to the fat pad overlying the scalenus anticus. The fat pad was removed. In addition the jugular chain was dissected and the nodes lying at the junction of the subclavian with the jugular vein were removed en masse. If no further nodes were discovered beneath the clavicle and over the upper borders of the innominate vein, the procedure was terminated by the usual accepted methods of wound closure.

RESULTS

One hundred and twenty-two cases are included in this study. The distribution of cases is recorded in Table I.

TABLE I. DISTRIBUTION OF CASES SELECTED FOR ROUTINE SCALENE NODE BIOPSY

DIAGNOSIS	NUMBER OF CASES
Carcinoma of lung histologically proved by other methods	71
Carcinoma of lung not proved but clinically acceptable as such	9
Inflammatory disease, benign	23
Metastatic disease in lung, primary site unsuspected at time of biopsy	5
Boeck's sarcoid, clinically	4
Lymphoma	4
Tuberculosis or tuberculoma	4
Carcinoma of esophagus	1
Mesothelioma	1
Total	122

In this series 125 biopsies were performed on 122 patients of which 3 were bilateral. The 122 cases yielded positive scalene nodes in 15 (12.3 per cent). The distribution of these positive biopsies is recorded in Table II.

TABLE II. RESULTS OF SCALENE NODE BIOPSY

*(Total Biopsies 125)**

Lymphadenitis or negative	110
Carcinoma metastatic from lung	6
Granuloma compatible with TBC	4
Boeck's sarcoid	2
Metastatic carcinoma other than primary lung	2
Thyroid 1	
Colon 1	
Lymphosarcoma	1
	125

*Three cases bilateral.

Harken and associates[2] reported an over-all positive biopsy of 45 in a series of 142 cases (31.7 per cent). His dissection included exploration of the anterior mediastinum. Connar[1] reports positive diagnoses in 14 out of 50 cases (28 per cent).

In our series of 71 cases of histologically proved carcinoma of the lung, positive scalene nodes were obtained in 6 cases (8.5 per cent).

TABLE III. POSITIVE BIOPSY OF SCALENE NODES IN PROVED BRONCHOGENIC CARCINOMA

	NUMBER OF CASES
Carcinoma of lung histologically proved	71
Positive scalene node biopsy	6

In many instances the diagnosis had not been histologically proved prior to scalene node biopsy and thoracotomy. In 11 such cases it was possible to establish a diagnosis prior to thoracotomy by node biopsy alone. Of these, 3 subsequently proved to have disease other than that revealed by scalene node biopsy. The distribution of these is shown in Table IV.

TABLE IV. CASES DIAGNOSED BY SCALENE NODE BIOPSY ALONE

DIAGNOSIS	NUMBER OF CASES
Granuloma compatible with TBC*	4
Carcinoma of lung	2
Boeck's sarcoid	2
Metastatic disease to lung	2
Thyroid 1	
Colon 1	
Lymphosarcoma	1
Total	11

*1 incidental to carcinoma of lung proved at thoracotomy.
1 incidental to lymphosarcoma proved at thoracotomy.
1 clinically considered Boeck's sarcoid—later proved to have sputum positive for TBC.

SUMMARY

1. A series of 122 cases of intrathoracic disease without palpable cervical nodes in which routine scalene node biopsy was performed resulted in 15 positive biopsies (12.3 per cent).

2. In 71 cases of proved bronchogenic carcinoma without palpable lymph nodes, 6 positive scalene node biopsies were found (8.5 per cent).

3. In 2 cases of bronchogenic carcinoma, the use of scalene node biopsy indicated the correct diagnosis when all other methods short of exploratory thoracotomy had yielded negative results.

4. In one case a diagnosis of TBC was reported from the scalene biopsy when in fact the patient was suffering from a primary pulmonary malignancy.

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EXPERIMENTAL ENZYMATIC DISSOLUTION OF SOFT TISSUE HEMATOMAS

I. Streptokinase-Streptodornase and Hyaluronidase

C. Allen Wall, M.D.,* and C. Rollins Hanlon, M.D., St. Louis, Mo.

(From the Department of Surgery, Saint Louis University)

WE HAVE investigated the effect of various enzymes, alone and in combination, in facilitating the resorption of experimentally produced hematomas in dogs. It is the purpose of this paper to compare the effects of adding streptokinase-streptodornase (SK-SD) and hyaluronidase to subcutaneous hematomas. Subsequent reports will cite our observations with other enzyme combinations. Since the initial work of Tillett and Garner,[2] the fibrinolytic activity of SK-SD has been used in a variety of clinical situations particularly designed to facilitate the lysis of blood clots. Similarly, scattered clinical reports have alluded to the benefits of hyaluronidase in aiding the resorption of subcutaneous blood accumulations. However, while clinical reports are encouraging, there have been no experimental studies designed to evaluate the merits of these enzymes when added to soft tissue hematomas.

It occurred to us that the dissolution of soft tissue hematomas might best be facilitated by combining the fibrinolytic property of SK-SD to promote liquefaction of the blood clot and the spreading factor of hyaluronidase to aid in dispersion of the liquefied blood.

In this study 21 adult mongrel dogs weighing from 7 to 12 Kg. were used. Intravenous Nembutal anesthesia was maintained for 2 to 3 hours. An area in each groin was isolated by placing 2 rubber-shod intestinal clamps across the skin folds with the tips of the clamps forming the apex of a triangle. A No. 15 needle was introduced into the heart and 100 c.c. of blood were withdrawn. Fifty cubic centimeters of blood were introduced into the subcutaneous tissue of each groin and allowed to clot. The clamps served to prevent dispersion of the blood as well as to create some degree of trauma to the adjacent tissue, a factor present in the genesis of most soft tissue hematomas. Thus, a preparation was available with a localized clotted hematoma in the subcutaneous tissue of each groin which would remain grossly discernible for 9 to 15 days when no enzymes were added. Appropriate comparisons with the use of enzymes could be made.

The clinical response in 21 dogs following the addition of enzymes to the hematomas was judged by the rate and degree of complete resorption of the blood clot. The hematomas of the left groin served as controls. Enzymes were added to the hematomas of the right groin. Individual animal variations were thus eliminated (Fig. 1).

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*Present address: Walter Reed Army Medical Center, Washington, D. C.

SK-SD Compared With Saline Control.—Five dogs were used in testing the effects of adding 25,000 units of SK and 6,250 units of SD diluted in 5 c.c. of saline to the previously produced subcutaneous hematomas of the right groin. The left groin served as the basis of comparison with 5 c.c. of saline solution added to a similar hematoma.

Hyaluronidase Compared With Saline Control.—A second group of 5 dogs with similarly produced hematomas compared the effect of adding 400 viscosity units of hyaluronidase diluted to 12 c.c. with saline solution to the right groin hematoma with the control hematoma of the left groin to which only 12 c.c. of saline solution were added.

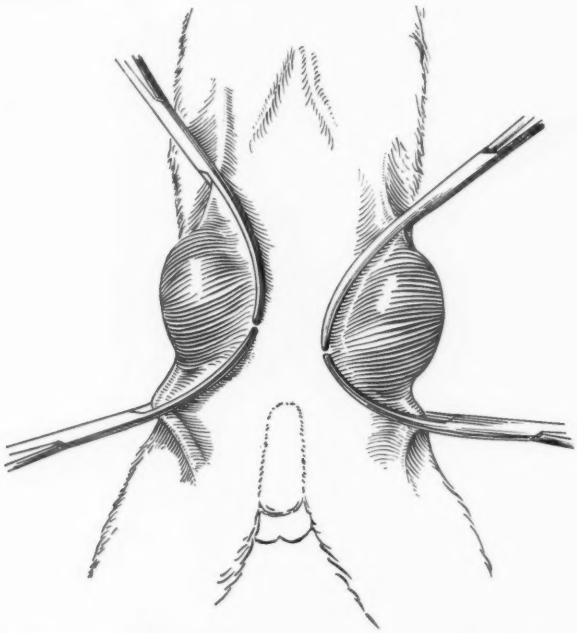

Fig. 1.—Subcutaneous hematoma in each groin.

SK-SD and Hyaluronidase Compared With Saline Control.—In a third group of 5 dogs there was added to the hematoma in the right groin a mixture of 50,000 units of SK, 12,500 units of SD, and 400 viscosity units of hyaluronidase, diluted to 12 c.c. with saline solution. This was compared with the hematomas in the left groin of the same animals to which 12 c.c. of saline solution were added.

SK-SD and Hyaluronidase Compared With SK-SD Alone.—Six dogs were used in the fourth group to compare the effects of adding 50,000 units of SK, 12,500 units of SD, and 200 viscosity units of hyaluronidase diluted to 12 c.c. of saline to the right groin hematoma with the effects of adding only 50,000 units of SK and 12,500 units of SD to the hematoma of the left groin.

In all 4 groups, daily measurements of the rate and degree of resorption of the hematomas were recorded.

RESULTS

SK-SD Compared With Saline Control.—SK-SD when added to the hematoma produced a smaller, softer hematoma in 24 hours in 4 of the 5 animals.

The rate of complete resorption was moderately accelerated in 3 of the 5 animals. (Fig. 2.)

Hyaluronidase Compared With Saline Control.—When hyaluronidase alone was added to the hematoma, neither the initiation of the resorptive process nor the time for complete dissolution were significantly accelerated (Fig. 3).

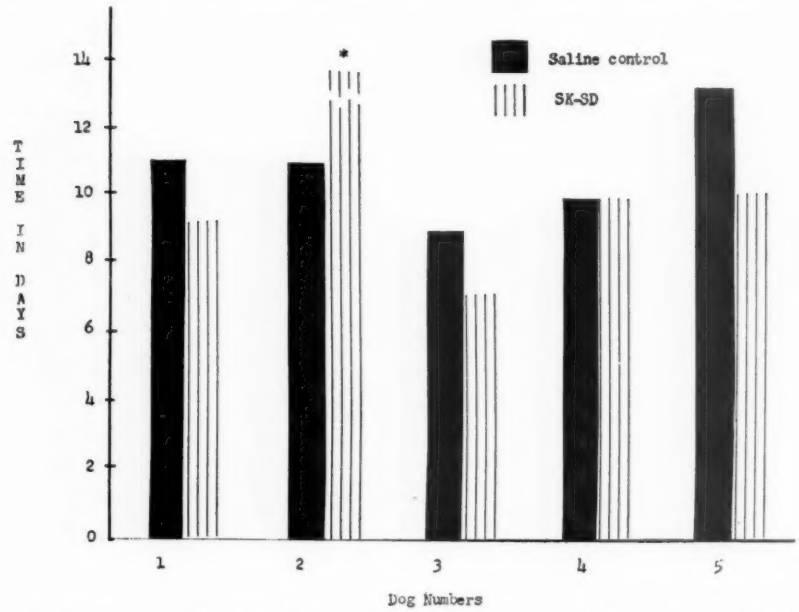

Fig. 2.—Response with SK-SD alone. *Hematoma infected and persisted for 20 days.

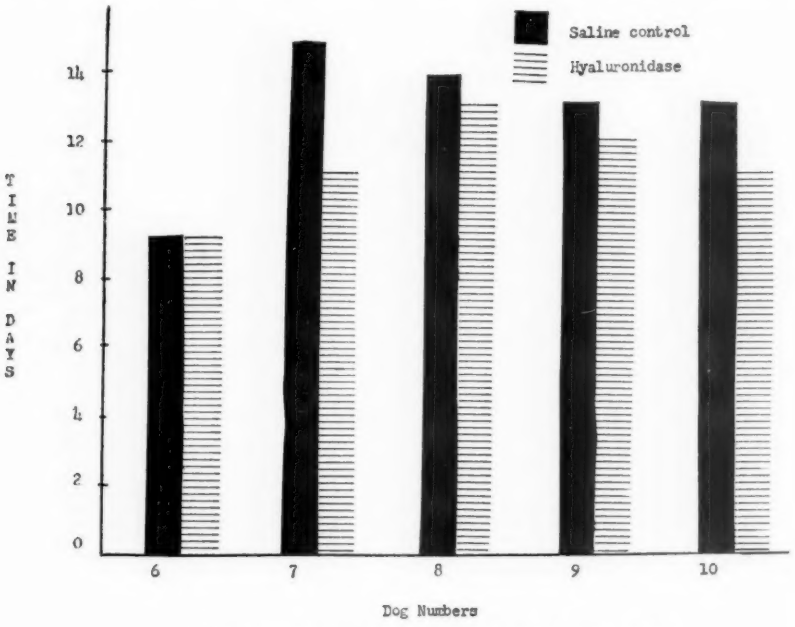

Fig. 3.—Response with hyaluronidase alone.

SK-SD and Hyaluronidase Compared With Saline Control.—The combination of SK-SD and hyaluronidase injected into the hematoma not only revealed a

smaller, softer hematoma in 24 hours, but also complete resorption was significantly accelerated in all 5 of the dogs (Fig. 4).

SK-SD and Hyaluronidase Compared With SK-SD Alone.—In comparing the effects of adding both SK-SD and hyaluronidase to the hematoma with the

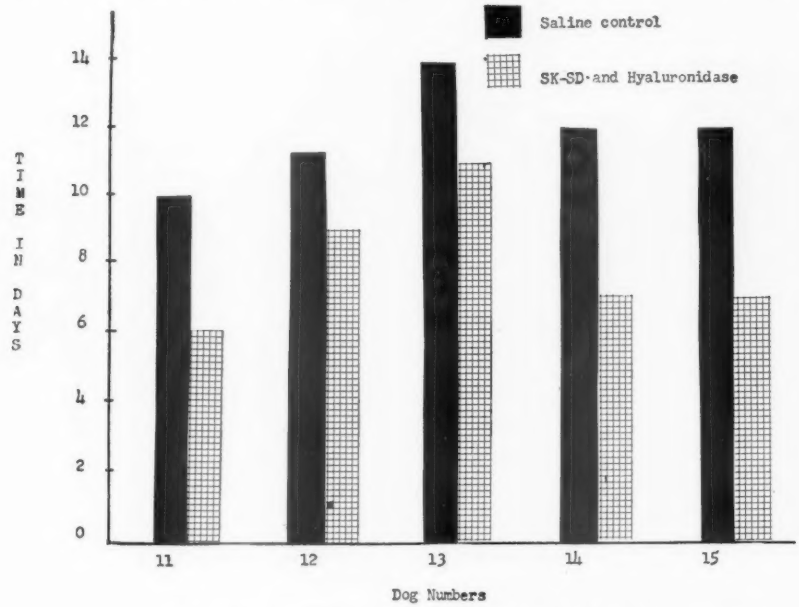

Fig. 4.—Response with both SK-SD and hyaluronidase.

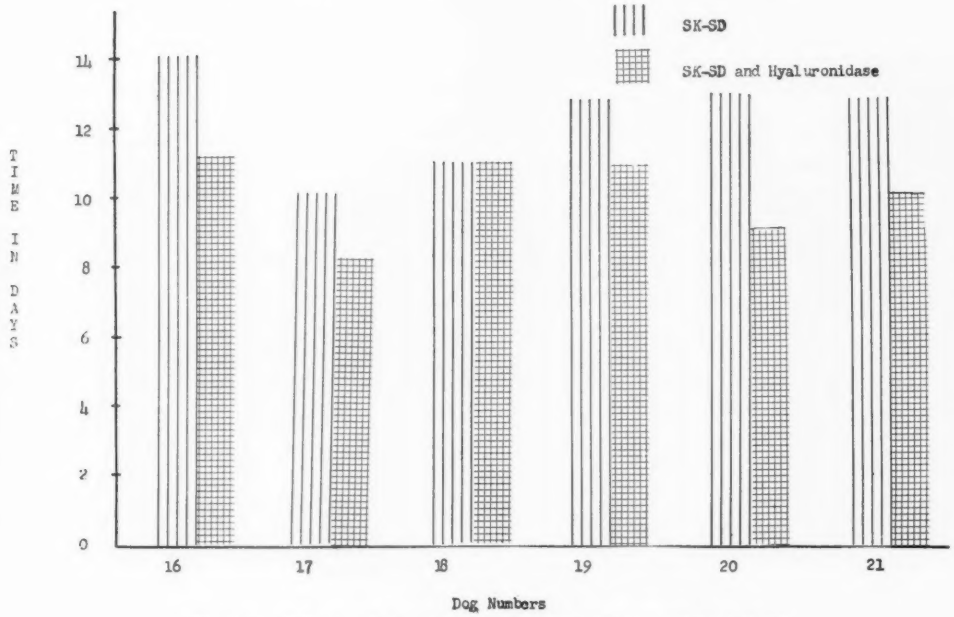

Fig. 5.—Effect of combining hyaluronidase with SK-SD.

addition of SK-SD alone, a smaller, softer hematoma within 24 hours occurred in 5 of the 6 dogs when both enzymes were used. The rate of resorption was accelerated in 5 of 6 dogs with the instillation of both enzymes. (Fig. 5.)

In a separate report the histologic behavior of the enzymes, both within the hematoma and in the adjacent tissue, will be cited in detail. In general, there were no deleterious effects to the tissue demonstrated in 24 dogs with hematomas produced similarly when SK-SD and hyaluronidase were added both alone and in combination.

DISCUSSION

The efficacy of streptokinase-streptodornase in the treatment of a clotted hemothorax suggests that it might be used to facilitate dispersal of soft tissue hematomas. Similarly, satisfactory acceleration of hematoma dissolution has been reported following injection of the hematoma with hyaluronidase. Imperati[1] has suggested the combined use of a fibrinolytic enzyme (SK-SD) with a dispersal agent (hyaluronidase) in the management of the postoperative hemothorax.

Liquefaction of the clot by fibrinolytic enzymes should accelerate resorption of the hematoma. The liquefied contents of the hematoma might be aspirated as is customary in hemothorax. However, the finely loculated character of soft tissue hematomas makes aspiration unsatisfactory and suggests the need for facilitating their dispersal by an enzyme such as hyaluronidase. If SK-SD alone accelerates the disappearance of a soft tissue hematoma, its combination with the dispersal action of hyaluronidase might be anticipated to be more efficient.

The observations recorded here indicate that hyaluronidase with SK-SD significantly accelerates the disappearance of soft tissue hematomas in dogs under the conditions cited. Histologic studies reported elsewhere demonstrate no deleterious effects to the tissue following the introduction of these enzymes into the hematoma.

It is suggested that soft tissue hematomas be managed clinically by the instillation into the hematoma of both SK-SD and hyaluronidase, one ampule of each, diluted to 10 to 20 c.c. with saline solution. This should be carried out as soon after the hematoma forms as is feasible and repeated daily for 2 or 3 days. The theoretical objection that SK-SD will initiate hemorrhage by lysis of the clot of a previously bleeding vessel has not been confirmed experimentally or clinically.

SUMMARY

Experimental studies in 21 dogs demonstrate that the addition of SK-SD and hyaluronidase in combination into experimentally produced soft tissue hematomas significantly accelerates the resorption of the hematoma.

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FAT EMBOLISM

Changes in the Level of the Blood Lipase Following the Intravenous Injection of Neutral Fat, Fatty Acids, and Other Substances Into Dogs

Leonard F. Peltier, M.D., Ph.D., and Joan Randolph Scott,
Minneapolis, Minn.

(From the Division of Orthopedic Surgery, Department of Surgery, University of Minnesota Hospitals)

FOLLOWING trauma to bone, either fracture or elective orthopedic operation, there is an increase in the level of blood lipase activity in about 25 per cent of the patients.[7-11] It is in this group of patients that the signs and symptoms of fat embolism appear and in which deaths due to fat embolism occur. It is the purpose of this investigation to observe the fluctuation of the blood lipase activity in dogs, in the absence of trauma following the intravenous injection of various substances including fat.

PROCEDURE

Adult mongrel dogs weighing 7 to 10 Kg. were used in all experiments. They were anesthetized lightly, in the fasting state, with sodium pentobarbital injected intravenously into a leg vein. A superficial jugular vein was then exposed in the neck. All subsequent injections were made via this vein, and all blood samples were removed from this vein.

An initial blood sample was obtained prior to the injection of the test material. Subsequent blood samples were drawn at hourly intervals. At the completion of the experiment, the animals were sacrificed by means of an overdose of sodium pentobarbital.

TEST MATERIALS

The dosage of all materials given intravenously was calculated in milligrams per kilogram. All materials were injected rapidly; the maximum time of injection was 15 seconds.

The source, composition, and procedures used to obtain the neutral human fat and the saponified human fat (free fatty acids) are described elsewhere.[4-6]

The mineral oil (long-chain neutral hydrocarbon) used had a viscosity of 47.2 c.p.

The starch particles administered consisted of a suspension of Bio-Sorb powder and water.

The composition of the 10 per cent fat emulsion used has been described by Jordan, Wilson, and Stuart.[4]

LIPASE DETERMINATIONS

Blood samples were drawn into clean dry tubes, allowed to clot, and then centrifuged to separate off the serum. The serum was then either frozen, to be thawed immediately before use, or the lipase determinations were carried out on the fresh serum no less than 45 minutes after obtaining the blood sample.

The serum lipase determinations were made according to the method of Goldstein, Epstein, and Roe.[1] This determination is based on the hydrolysis of a suspension of

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The fat emulsion used in this experiment was furnished by Don Baxter, Inc., Research and Development Laboratories, Glendale, Calif.

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tributyrin buffered with calcium acetate and sodium diethyl barbiturate. The reaction was carried out in an incubator at 37° C. for one hour and then terminated by the addition of an alcohol-ether solution. The fatty acid freed by hydrolysis was titrated with 0.05 N KOH to an end point using phenolphthalein as an indicator. Individual blanks were run with each determination to allow correction for the titrable acidity of the serum itself. The lipase activity of one cubic centimeter of serum is expressed in terms of cubic centimeters of 0.05 N KOH consumed in titration.

RESULTS

The raw data from each group of animals are presented in the tables. The mean values in each group of animals are presented in graphic form from the mean initial value (0.75 c.c.) of the normal serum lipase as determined in a group of 68 animals. Forty of these animals are those reported on in this study and the data from the remaining 28 animals were collected earlier.

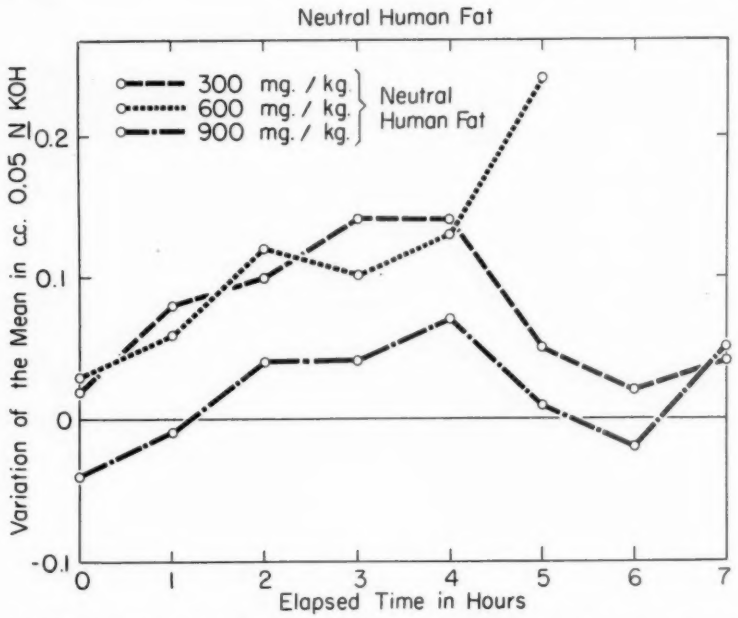

Fig. 1.—Fluctuation of the serum lipase levels in dogs following the intravenous injection of neutral human fat. Each line represents the variations of the mean serum lipase levels in a group of 5 dogs.

Five dogs were used as controls. In these animals, blood samples were drawn at hourly intervals, but no injection of fat or other substances was made. The results are shown in Table I and Fig. 4.

TABLE I. THE SERUM LIPASE LEVELS IN NORMAL FASTING DOGS ANESTHETIZED WITH SODIUM PENTOBARBITAL

DOG NUMBER	ELAPSED TIME IN HOURS							
	0	1	2	3	4	5	6	7
625	.86	.82	.99	.74	.95	.97	.85	.88
600	.95	.87	.87	.86	.87	.86	.89	.89
453	.77	.88	.81	.76	.52	.68	.67	.87
492	(.70)	.70	.75	.66	.69	.63	.73	.77
1614	.83	.95	.75	.86	.89	.94	.88	.81
Mean	.82	.84	.83	.78	.78	.82	.80	.84
Variation of mean from .75 c.c.	+.07	+.09	+.08	+.03	+.03	+.07	+.05	+.09

Figures represent cubic centimeter of 0.05 N KOH.

TABLE II. THE SERUM LIPASE LEVELS IN NORMAL FASTING DOGS ANESTHETIZED WITH SODIUM PENTOBARBITAL FOLLOWING THE INTRAVENOUS INJECTION OF NEUTRAL FAT

DOSAGE	DOG NUMBER	ELAPSED TIME IN HOURS							
		0	1	2	3	4	5	6	7
300 mg./Kg.	1777	.90	.91	.95	1.04	1.20	.85	.89	.88
	1892	.92	.94	.99	1.04	.98	.95	.84	.84
	1818	.47	.78	.78	.55	.80	.57	.71	.67
	1890	.70	.66	.69	.74	.66	.78	.53	.72
	1822	.87	.87	.84	1.09	.79	.83	.88	.86
	Mean	.77	.83	.85	.89	.89	.80	.77	.79
	Variation of mean from .75 c.c.	+.02	+.08	+.10	+.14	+.14	+.05	+.02	+.04
600 mg./Kg.	1300	.66	.80	.79	.88	.76	.59	1.01	
	254	.98	.93	1.07	1.03	1.30	1.20		
	1959	.85	.90	.95	.93	.87	1.21		
	328	.58	.65	.61	.63	.70	.85	.60	.59
	250	.84	.78	.91	.77	.76	1.13	1.06	.98
	Mean	.78	.81	.87	.85	.88	.99		
	Variation of mean from .75 c.c.	+.03	+.06	+.12	+.10	+.13	+.24		
900 mg./Kg.	1654	.59	.77	.81	.77	(.74)	.71	.66	.78
	1719	.90	.90	1.07	1.08	(1.05)	1.05	.98	.96
	1600	.79	.72	.78	.75	.81	.76	.73	.85
	1621	.70	.59	.76	.63	.76	.66	.71	.83
	1514	.58	.71	.54	.73	.74	.62	.58	.58
	Mean	.71	.74	.79	.79	.82	.76	.73	.80
	Variation of mean from .75 c.c.	−.04	−.01	+.04	+.04	+.07	+.01	−.02	+.05

Figures represent cubic centimeter of 0.05 N KOH.

TABLE III. THE SERUM LIPASE LEVELS IN NORMAL FASTING DOGS ANESTHETIZED WITH SODIUM PENTOBARBITAL FOLLOWING THE INTRAVENOUS INJECTION OF SAPONIFIED HUMAN FAT (FREE FATTY ACIDS)

DOSAGE	DOG NUMBER	ELAPSED TIME IN HOURS							
		0	1	2	3	4	5	6	7
75 mg./Kg.	230	.71	.90	.89	.84	.73	.85	.83	.83
	217	1.14	1.20	1.47	1.35	1.31	1.52	1.37	1.29
	221	.42	.71	.59	.58	.75	.78	.77	.61
	22	.59	.84	.71	.67	.79	.79	.92	.90
	323	.43	.49	.62	.62	.62	.79	.63	.72
	Mean	.66	.83	.86	.81	.84	.94	.90	.87
	Variation of mean from .75 c.c.	−.09	+.08	+.11	+.06	+.09	+.19	+.15	+.12
150 mg./Kg.	1904	.73	.71	.85	Dead				
	76	.58	.75	.85	Dead				
	130	.66	.83	1.06	Dead				
	1983	1.16	1.10	1.42	Dead				
	Mean	.78	.85	1.04	—				
	Variation of mean from .75 c.c.	+.03	+.10	+.29					

Figures represent cubic centimeter of 0.05 N KOH.

Three groups of 5 dogs each were injected with neutral human fat in a dosage of 300, 600, and 900 mg. per kilogram, respectively. The fat was injected intravenously immediately after obtaining the initial blood sample. The results are shown in Table II and Fig. 1.

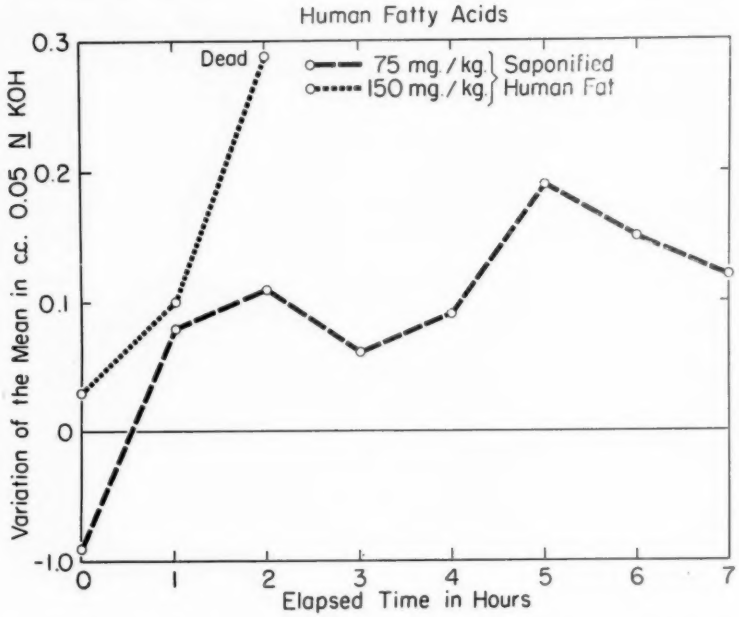

Fig. 2.—Fluctuation of the serum lipase levels in dogs following the intravenous injection of saponified human fat (free fatty acids) into dogs. The dotted line represents the variations of the mean serum lipase levels in a group of 4 dogs; the other line, in a group of 5 dogs.

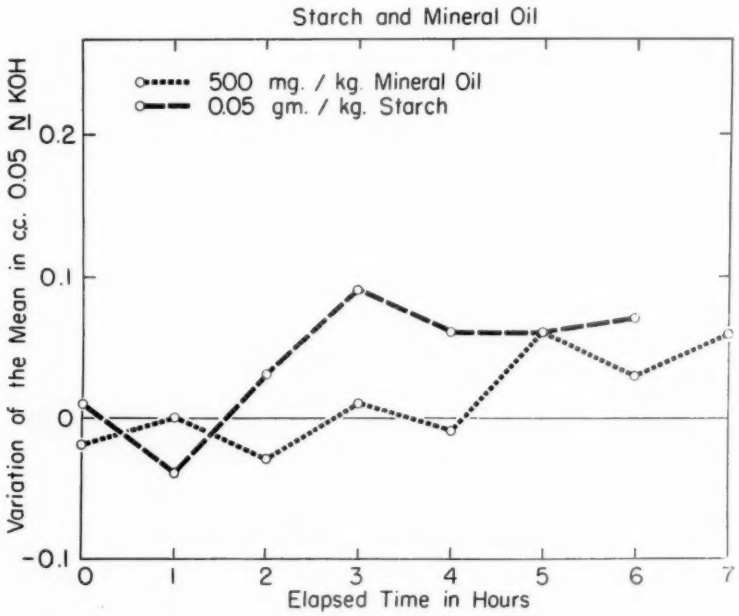

Fig. 3.—Fluctuations of serum lipase levels in dogs following the intravenous injection of mineral oil and starch particles. The dotted line represents the variations of the mean of 5 dogs; the broken line, of 6 dogs.

Saponified fat was injected into two groups of dogs. Five received 75 mg. per kilogram; 4 were given 150 mg. per kilogram. All of the animals in the latter group died between 2 and 3 hours after injection. The results are shown in Table III and Fig. 2.

Mineral oil (500 mg. per kilogram) was injected into a group of 5 dogs. The results are shown in Table IV and Fig. 3.

TABLE IV. THE SERUM LIPASE LEVELS IN NORMAL FASTING DOGS ANESTHETIZED WITH SODIUM PENTOBARBITAL FOLLOWING THE INTRAVENOUS INJECTION OF MINERAL OIL (500 MG./KG.)

DOSAGE	DOG NUMBER	ELAPSED TIME IN HOURS							
		0	1	2	3	4	5	6	7
500 mg./Kg.	260	.70	.78	.84	.89	.92	1.01	.93	1.00
	303	.88	.94	.73	.94	.73	.81	.77	.91
	1655	.54	.55	.55	.55	.52	.58	.53	.57
	397	.86	.75	.83	.71	.73	.82	.91	.85
	306	.67	.71	.67	.73	(.78)	.82	.74	.72
	Mean	.73	.75	.72	.76	.74	.81	.78	.81
	Variation of mean from .75 c.c.	−.02	.00	−.03	+.01	−.01	+.06	+.03	+.06

Figures represent cubic centimeter of 0.05 N KOH.

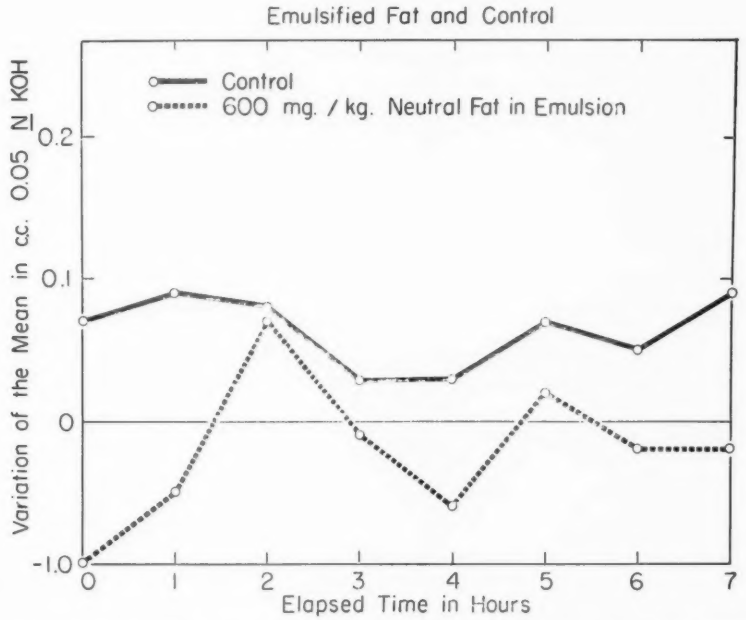

Fig. 4.—Fluctuations of the serum lipase levels in dogs following the intravenous injection of a 10 per cent fat emulsion. Each line represents the variations of the mean values in a group of 5 dogs.

Starch particles (0.05 Gm. per kilogram) in water suspension were injected into a group of 6 dogs. The results are shown in Table V and Fig. 3.

Each of 5 dogs was given intravenously 6 c.c. per kilogram of a 10 per cent emulsion of neutral fat (600 mg. per kilogram). The serum of all of the animals was lipemic at the end of the first hour. This persisted through the second

hour in all but one dog. At the end of 3 hours, there was visible lipemia in the serum from only one dog, and this was in very slight degree. The results are shown in Table VI and Fig. 4.

TABLE V. THE SERUM LIPASE LEVELS IN NORMAL FASTING DOGS ANESTHETIZED WITH SODIUM PENTOBARBITAL FOLLOWING THE INTRAVENOUS INJECTION OF STARCH PARTICLES (SUSPENSION OF BIO-SORB POWDER 0.05 GM./KG.)

DOG NUMBER	0	1	2	3	4	5	6
J 19 W	.55	.45	.66	1.01	.89	.80	.84
J 19 S	.95	.68	.89	.72	.84	.84	.81
B-15	.88	.95	.77	.88	.66	.68	.70
1173	.70	.52	.74	.76	.91	.86	.96
J 3 W	.57	.60	.70	.70	.80	.79	.75
J 3 B	.92	1.05	.94	.99	.06	.89	.87
Mean	.76	.71	.78	.84	.81	.81	.82
Variation of mean from .75 c.c.	+.01	−.04	+.03	+.09	+.06	+.06	+.07

Figures represent cubic centimeter of 0.05 N KOH.

TABLE VI. THE SERUM LIPASE LEVELS IN NORMAL FASTING DOGS ANESTHETIZED WITH SODIUM PENTOBARBITAL FOLLOWING THE INTRAVENOUS INJECTION OF A FAT EMULSION (600 MG. NEUTRAL FAT/KG.)

DOG NUMBER	0	1	2	3	4	5	6	7
1376	.45	.54	.50	.57	.55	(.29)	.46	.56
B-10	.72	.93	.76	.76	.71	.89	.85	.66
B-11	.66	.59	.90	.67	.71	.73	.52	.62
B-12	.59	.59	.91	.63	.68	.73	.67	.59
B-13	.85	x(.85)	1.02	1.08	.81	1.06	.88	.99
Mean	.65	.70	.82	.74	.69	.77	.68	.68
Variation of mean from 0.75 c.c.	−.10	−.05	+.07	−.01	−.06	+.02	−.07	−.07

Figures represent cubic centimeter of 0.05 N KOH.

DISCUSSION

The serum lipase levels in fasting dogs anesthetized with sodium pentobarbital did not change appreciably over a period of 7 hours. The injection of mineral oil (a long-chain neutral hydrocarbon) or starch particles into similar animals did not affect the serum lipase levels. The injection of neutral fat and saponified neutral fat (free fatty acids) was associated in an increase in serum lipase activity during the 7 hours after injection. A similar elevation of the serum lipase has been said to occur in rabbits after the intravenous injection of mineral oil.[2] When neutral fat as an emulsion was given intravenously, no elevation of the serum lipase occurred.

The data indicate that the stimulus to increased serum lipase activity is miliary pulmonary embolism with neutral fat or free fatty acids. Other forms of miliary pulmonary embolism with similar mechanical effects do not produce this change in serum lipase activity. Neutral fat in an emulsion does not become embolic in the lung and does not affect the serum lipase. It would appear probable therefore that the lipase may be secreted as an extra respiratory function of the lung as a response to the presence of the fat as miliary pulmonary emboli.

The elevation of serum lipase activity in patients with fractures is most probably due to the entry into the blood stream of quantities of neutral fat from the local site of injury with resulting miliary pulmonary fat embolism.

CONCLUSION

The intravenous injection of neutral fat and saponified neutral fat into dogs results in an increase in serum lipase activity. This increase does not occur following the intravenous injection of emulsified neutral fat, mineral oil, or starch particles.

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A CARDIAC PUNCH INSTRUMENT

RAY O. HEIMBECKER, M.D., TORONTO, ONTARIO

(From the Department of Surgery, University of Toronto and Toronto General Hospital)

AS THE field of experimental cardiac surgery broadens, the need for instruments to suit special purposes becomes more evident.

This instrument* was designed to remove a complete plug of myocardium with minimal trauma and blood loss. It was developed in the course of experiments in which a prosthetic aortic valve was placed through the apex of the left ventricle, in an effort to by-pass the diseased aortic valve. Great advantages were found over previously described methods[2] in that there was much less cardiac manipulation, only a very small portion of the instrument entered the cardiac chambers, and blood loss was minimal, often totalling only 20 to 30 c.c. A plug of myocardium was removed, which was always cleanly cut and had a full endocardial surface. It has been used successfully on 40 experimental animals.

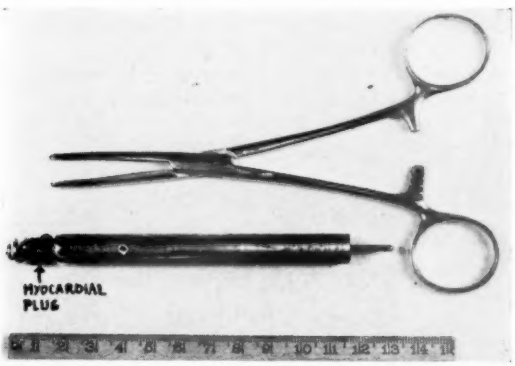

Fig. 1.—Cardiac punch with corkscrew protruding from the carefully honed cutting end. A cleanly cut plug of myocardium is present in the corkscrew. The Kelly clamp is applied to the corkscrew shaft to aid in the manipulation of the corkscrew.

The instrument consists of a simple cylindrical steel punch (8 mm. in diameter for our purposes), similar to that used for skin biopsies. A corkscrew device is present at the cutting end of the punch. The corkscrew slides in and out of the punch on a shaft. A Kelly clamp is applied to the protruding shaft.

To use the instrument, the corkscrew is rotated into the myocardium until the corkscrew enters the heart chamber. The punch is then advanced into

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*Obtainable from J. F. Hartz Co., Grenville Street, Toronto, Ontario.

the myocardium, while at the same time countertraction is applied with the corkscrew. When the myocardial plug has been completely cut through, the instrument lies free, and can be rapidly removed as the prosthesis is inserted.

Preliminary experiments indicate that the instrument is very useful for creating experimental septal defects.

There seems to be a real clinical application of the instrument as well, in that it has already been used on several patients with success.[1]

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Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

CLOSED CHEST DEFIBRILLATION OF THE HEART

W. B. KOUWENHOVEN, DR.ING.,* W. R. MILNOR, M.D.,** G. G. KNICKERBOCKER, B.S.,*** AND WILLIAM R. CHESNUT, M.D.,**** BALTIMORE, MD.

(From the Schools of Engineering and Medicine of The Johns Hopkins University)

INTRODUCTION

VENTRICULAR fibrillation is a disturbance from which the human heart rarely recovers spontaneously and is fatal if not terminated promptly. Although many drugs are known to have an antifibrillatory action,[2] the clinical emergency resulting from ventricular fibrillation leaves little time for their use, and the only reliable method of treatment is to send sufficient electric current through the heart to arrest the fibrillatory process.

Prevost and Battelli[13] reported in 1899 that they had been successful in arresting ventricular fibrillation in the exposed heart of the dog by sending through it either the discharge of a capacitor or an alternating current. These methods were studied by Hooker and associates,[6] who reported their success with alternating current and later developed equipment[9] for hospital use. Beck,[1] in 1947, reported the first successful application of this method to a fibrillating human heart with complete recovery of the patient. He also developed cardiac massage as a means of maintaining the circulation while the defibrillating equipment was being made available.

When the heart is already exposed, the open-chest method of defibrillation with the electrodes directly on the surface of the heart is the preferable method, as the condition of the heart may be observed directly and the circulation maintained by cardiac massage.

If fibrillation develops during a surgical procedure not involving thoracotomy, the opening of the patient's chest involves not only a second incision but a loss of time. Defibrillation through the unopened chest, however, presents certain problems. One of these is the difficulty in obtaining sufficient current density throughout the heart to bring all of its fibers to rest without damage to either the nervous system or to other body structures. Second, as effective

*Professor Emeritus of Electrical Engineering and Lecturer in Surgery, The Johns Hopkins University.

**Assistant Professor of Medicine, The Johns Hopkins University.

***Junior Instructor in Electrical Engineering, The Johns Hopkins University.

****Fellow in Medicine, The Johns Hopkins University.

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cardiac massage cannot be used, it is particularly important that the defibrillatory current be applied promptly before either the central nervous system or the heart have suffered irreversible damage from anoxia.

Methods of resuscitating individuals suffering from ventricular fibrillation without the necessity of opening the chest have been sought for some time. In 1936, Ferris and co-workers[3] reported that they had successfully defibrillated, through the closed chest, the ventricles of the sheep's heart by sending an alternating current of 25 amperes through the animal's chest between electrodes strapped to the opposite sides of the chest. Guyton and Satterfield,[5] MacKay and Leeds,[12] and Gurvich and Yuniev[4] have all made significant contributions in this field, and Zoll and his colleagues[15] have recently reported a group of cases in which closed chest defibrillation was carried out successfully on man.

OBJECTIVE

In 1951, with the cooperation of Dr. Alfred Blalock and with funds supplied by the Edison Electric Institute, a study of the closed chest methods of defibrillation was inaugurated at The Johns Hopkins University. The objective of this research was to develop a closed chest method of defibrillation that would: (a) insure a sufficient current density throughout the heart to arrest the fibrillation, (b) provide a maximum degree of safety to the patient and the staff, and (c) require a minimum amount of electrical energy. If the method proved feasible, suitable equipment for its application was to be provided. Portions of this work have been reported in detail elsewhere.[7, 8, 10, 11] The purpose of the present report is to summarize the results of this investigation and present additional data.

PROCEDURE

Dogs were selected as the experimental animal because of the abundant evidence that the reaction of the dog heart and the human heart to electric currents are closely analogous. The animals ranged in weight from 7 to 20 Kg. All were anesthetized with morphia and ether. The latter, mixed with air, was administered through an endotracheal tube by a positive pressure respirator. During the interval that the heart was in ventricular fibrillation, the ether was discontinued and respiration was maintained with room air.

When the animal was anesthetized the hair was shaved from the chest and extremities. During each experiment the heart action was monitored with an electrocardiograph using leads attached either to the extremities or to esophageal and chest electrodes. Blood pressure in a femoral or carotid artery was recorded by means of a transducer.

The copper defibrillating electrodes were either strapped on the chest or were mounted on insulating handles so as to be applied manually. The chest electrodes were strapped in the desired positions on the opposite sides of the chest before beginning an experiment. The hand electrodes were held by the operator and were pressed in position on the animal's body when the defibrillating current was to be applied. A foot switch was used by the operator to apply the current.

The depth of anesthesia was decreased until the corneal reflex was detectable, and control ECG and blood pressure records were taken. The animal's heart was then thrown into ventricular fibrillation by a 120-volt, 60-cycle shock. The presence of fibrillation was established by the characteristic ECG tracing and fall of blood pressure. After the heart had been fibrillated for the desired interval, the defibrillating current was applied.

If the animal survived, the test was repeated after an interval of 15 or 20 minutes. Some animals were defibrillated as many as 6 to 9 times in the course of a single experiment. If the first application of the defibrillating current failed to arrest the ventricles, the application was repeated after an interval of about 20 seconds.

The experiments were designed to answer a number of specific questions.

1. What is the comparative effectiveness of capacitor discharges and 60-cycle alternating current in defibrillating the ventricles?

2. What electrode positions on the body surface are most efficacious in providing the necessary current concentration in the heart while avoiding high current density in the spinal cord?

3. What shape and size should the electrodes be in order to provide low contact resistance with the body and eliminate the danger of burning the skin?

4. What increases in temperature in the skin directly under the electrodes and in the heart will be produced by the defibrillating current?

5. What is the optimal current for closed-chest ventricular defibrillation and what voltage is required to produce that current?

6. What are the effects of single applications of alternating current in the absence of ventricular fibrillation, and following defibrillation?

7. How does duration of fibrillation affect the probability of successful resuscitation?

CAPACITOR DISCHARGES

The use of capacitor discharges for defibrillation is an intriguing one because of the infinite number of wave forms that a capacitor discharge may be made to assume as the parameters of the discharge circuit are changed. Defibrillation experiments[7, 11] were carried out with capacitors ranging in size from 25 to 1,250 microfarads, charged to voltages from 4,000 to 450 volts, and with various values of resistance and inductance in the discharge circuit. Out of 35 experiments there were 13 successful defibrillations. It was found that if the animal's heart had been left in fibrillation for more than 30 seconds the chance of a successful recovery was slight. The proportion of successful defibrillations was lower with capacitor discharges than with single applications of alternating current, and in many instances the fibrillation was successfully arrested by the application of alternating current after two or more successive capacitor discharges had failed. For this reason our attention has been focused on alternating current but this does not mean that the capacitor method should not be further explored. There may exist some combination[4] of capacitors, inductances, and resistances or of capacitor and auxiliary equipment[14] which will prove ideal, even though our capacitor experiments to date have not produced encouraging results.

A.C. DEFIBRILLATION

The most reliable and effective method of ventricular defibrillation tested was found to be a single application or burst of 60-cycle alternating current which we have named "A.C. defibrillation." Fibrillation was successfully arrested after hearts had been in this condition, without massage, for periods up to 14 minutes.

In 107 experiments[13] with the chest electrodes, 72 animals were defibrillated and 42 of these survived. In 401 experiments with the hand electrodes (see Table I), 400 animals were defibrillated and of these 318 were returned to their cages alive. The best positions for the hand electrodes were determined by opening the chest and encircling the heart with a small through-type current transformer.[8] After the incision had been closed, the hand electrodes were held in various positions and the percentage of current passing through the heart measured.

Fig. 1.—Electrodes in position on the chest of a patient.

Maximum current through the heart is obtained by placing one hand electrode on the suprasternal notch and the other on the left mid-clavicular line at the level of the xiphoid (Fig. 1).

ELECTRODES

The electrodes were all of soft sheet copper. In order to determine the most effective form and size, experiments were conducted with electrodes of different sizes, shapes, and mountings. The chest electrodes that gave the best results on the dog were rectangular and 4 by 6 inches in size.

Hand electrodes which have been developed for human use are shown in Fig. 2. The soft copper discs are cemented on the surface of a one-quarter inch thick plastic disc, mounted on 6-inch long, 1-inch diameter, hollow plastic tubes that serve as handles. The connection to the copper electrode is made by an

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insulated conductor that passes through the tube. To eliminate the possibility of the operator making accidental contact with either the body of the patient or with the copper electrode, an additional plastic guard is mounted on the tube a full inch above the electrode.

The resistance offered by the human body to the flow of electricity and the possibility of burning the skin are factors in determining electrode size. A large portion of the resistance of the body resides in the epidermis, which has a high electrical contact resistance per square centimeter. The total contact resistance may be reduced by increasing the area, but if the area is made too large there may not be space on the chest to locate the electrodes properly.

The initial set of hand electrodes constructed had a cross-sectional area of 25 square inches. The present electrodes (Fig. 2), which have been used successfully several hundred times in animal experiments, are 9 square inches (58 cm.^{2}) in area. The operator, in using these electrodes, applies a liberal coating of ECG electrode jelly to the copper surfaces and works it into the skin by rubbing. The electrodes are applied with a pressure of 7 to 10 pounds to insure low contact resistance.

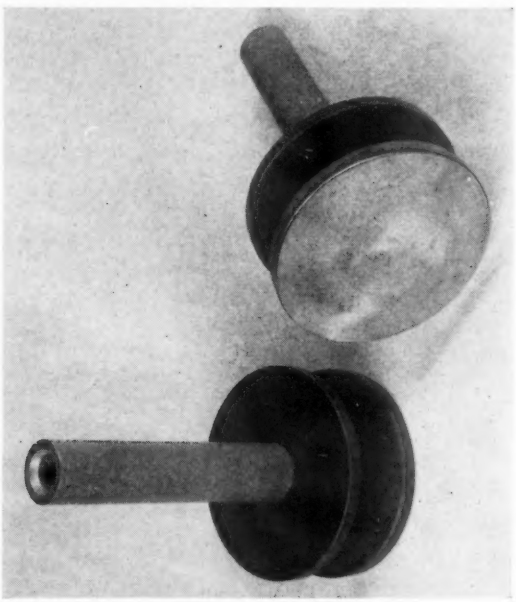

Fig. 2.—Hand electrodes for man.

It should be recognized that even on the exposed heart, small-sized electrodes and a light pressure may result in a high contact resistance and insufficient current through the heart to defibrillate. To compensate for this deficiency some surgeons call for higher defibrillating voltages with the greater inherent risk of thermal damage to the myocardium.

In dogs the resistance of the transverse current path, using the 4- by 6-inch chest electrodes, was found to range from 35 to 60 ohms and that of the

longitudinal path, with the 9-square-inch hand electrodes, from 65 to 120 ohms. The resistance of the longitudinal current path in adult man was measured on fresh cadavers and found to vary between 67 and 90 ohms.

TEMPERATURE RISE

The rise in body temperature produced by passage of the A.C. defibrillating current through the chest was measured in 3 animals by thermocouples inserted in the skin under the mid-point of the electrodes and into the right ventricular cavity. A current of 0.07 ampere per square centimeter (0.45 ampere per square inch) of electrode surface, flowing for one second, produced a temperature increase varying from 0.01 to 0.2° C. in the heart. A current of 0.08 ampere per square centimeter flowing for 5 seconds raised the heart temperature 0.85° C. The maximum temperature rise found in the skin was 3.4° C. for 0.06 ampere per square centimeter flowing for 1.25 seconds. In no instance was there any evidence of blistering or burning of the tissues.

CURRENT AND VOLTAGE

In the transverse flow direction the current needed to defibrillate the ventricles ranged from 8 to 12 amperes. In 19 consecutive longitudinal path experiments the defibrillating current ranged from 3.5 to 6.7 amperes, the average being 5.1 amperes.

The voltage applied to the electrodes to send the defibrillating current through the chest was varied from 240 to 900 volts. A potential of 480 volts open circuit voltage proved sufficient and has been adopted as standard. At The Johns Hopkins Hospital the actual voltage across the electrodes drops to about 440 volts while the current is flowing. This drop is caused by the impedance of the hospital supply circuits and of the equipment.

It is clear that the longitudinal current path requires approximately one-half the energy used in the transverse path to produce the same end result.

OPTIMAL DURATION OF THE DEFIBRILLATING SHOCK

In the early stages of this investigation, it was customary to apply the defibrillating current for one second per minute that the heart had been in fibrillation. In a number of experiments this resulted in cardiac standstill and failure of the animal to survive. A one-quarter second duration has been found to be sufficient to arrest fibrillation even when the fibrillation is of long duration. Should the initial application fail a second application may be given some 15 or 20 seconds later.

EFFECTS OF A.C. DEFIBRILLATION

Effects on Hearts With Normal Rhythm.—In order to determine the danger of applying A.C. defibrillation shock when the normal sinus rhythm was present, the current was sent through the chests of 43 dogs whose hearts were beating normally. In no experiment did the application of the defibrillating current result in any injury. A number of these animals were kept alive and apparently

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remained in good health for periods of from one week to 2 months before being sacrificed and subjected to autopsy. No gross evidence of damage to the heart or lungs was found.

Effects of Multiple Defibrillations.—In addition, over 42 animals were subjected to multiple defibrillations using the hand electrodes. Twelve were defibrillated twice and others from 3 to 9 times. A number of these animals were kept alive for 2 months or more and then were subjected to autopsy. Again no gross evidence of trauma was found.

Fig. 3.—*A*, Tachycardia following A.C. defibrillation. *B*, Atrial fibrillation following A.C. defibrillation.

Supraventricular arrhythmias were sometimes present following A.C. defibrillation. Nodal or atrial tachycardia was observed only occasionally, while atrial fibrillation was quite common. These arrhythmias persisted only a few seconds to a minute before normal sinus rhythm returned. The electrocardiograms of Fig. 3 illustrate the 2 arrhythmias and the return of the normal rhythm, which in all cases was an abrupt one, taking place in a single heart cycle. Both of these animals survived and were returned to their cages.

EFFECT OF DURATION OF THE FIBRILLATION ON SURVIVAL

In most experiments no difficulty was experienced in arresting fibrillation in hearts that had been in this state for periods up to 14 minutes. In such prolonged cases, however, the hearts remained in standstill after defibrillation

TABLE I. CLOSED CHEST DEFIBRILLATION WITH HAND ELECTRODES

DURATION OF FIBRILLATION (MINUTES)	NUMBER OF TESTS	NUMBER DEFIBRILLATED FIRST ATTEMPT	NUMBER SURVIVING	PERCENTAGE DEFIBRILLATED FIRST ATTEMPT	PERCENTAGE SURVIVING
0.5	224	214	221	95	99
1.0	68	63	61	93	90
1.5	68	56	26	82	38
2.0	30	27	8	90	27
2.5	2	2	1	100	50
3.0	4	4	1	100	25
4.0	1	0	0	0	0
5.0	4	1	0	25	0

Fig. 4.—Hospital defibrillator.

and the animals died. The limiting factor in successful closed chest resuscitation is, therefore, how long the ventricles can remain in fibrillation and still be capable of resuming normal contractions after defibrillation.

A series of experiments were carried out on dogs in which the ventricles were allowed to remain in fibrillation for periods of one-half to 5 minutes. If the first A.C. defibrillation failed a second one was given 15 to 20 seconds later. The results of this series of 401 closed chest defibrillations are recorded in Table I. In these tests there was only one animal whose heart we were unable to defibrillate.

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If the condition of ventricular fibrillation is recognized promptly and A.C. defibrillation is applied within one minute, the chances of re-establishing circulation and of survival are better than 9 out of 10. As the duration of fibrillation increases the chance of survival decreases. No survivals were observed in the relatively small group of animals in which fibrillation had persisted for 4 minutes or more. It seems clear that under present circumstances thoracotomy and manual cardiac massage are essential unless closed chest defibrillations can be undertaken within 2 minutes. The use of closed chest defibrillation will ordinarily be limited, for this reason, to surgical operating rooms or recovery wards where the equipment is instantly available.

HOSPITAL EQUIPMENT FOR HUMAN CASES

The tests reported in Table I provided an opportunity to give the equipment that was being developed for use in the hospital a thorough trial and at the same time to carry out a study of the effects of electric shocks of varying durations and occurring at different positions in the cardiac cycle.

The equipment that has been developed for hospital use is shown in Fig. 4. It is mounted on a movable table 16 by 20 inches in size and 30 inches high. On the lower shelf is a 3 K.V.A. low impedance, 60-cycle, 120-volt primary, 240/480 volt secondary, isolation transformer. The explosion-proof foot switch is shown on the floor in front of the table. At the left, on the table top, is a main switch for opening the 120-volt supply. It is normally left in the "ON" position. When the equipment is connected to the 120-volt house circuit, the pilot lamp at the top center lights. At the extreme right on the top is a clock-driven timer for controlling the duration of defibrillating current. This timer contains an electric clock, which starts immediately when the power is on. A clock timer was selected because it requires no warm-up time. Between the pilot lamp and the timer there is a selector switch for making available at the electrodes either 480 volts for adults or 240 volts for small children.

When the foot switch is pressed a relay in the timer closes and remains closed for the interval (0.25 second) to which the timer is set. The operation of the timer closes the main contactor which is located in the box that may be seen on the right-hand panel of the table just below the electrodes. A holder on the opposite side of the table contains a tube of ECG electrode jelly. The electrodes are held in place by clips and each is equipped with a 15-foot coiled lead.

At The Johns Hopkins Hospital the voltage at the convenience outlets is nominally 120 volts, and this provides an open circuit secondary voltage of 480 volts. When the defibrillator is operated the voltage at the electrodes drops to approximately 440 volts because of the resistance in the circuit.

OPERATION

The A.C. defibrillator may be used in wards, operating rooms, or in any part of a hospital. Either an electrocardiograph or an oscilloscope should be used in conjunction with the equipment to monitor the heart action.

The instructions for operation are:

1. Plug the power connection into a convenient 120-volt A.C. outlet.
2. The main switch should be in the "ON" position and the pilot lamp lighted.

3. Place the foot switch on the floor adjacent to the patient.

4. The selector switch should be in the adult position except for children weighing less than 50 pounds.

5. The timer setting should be 0.25 second.

6. Put electrocardiograph jelly on the copper electrodes.

7. Place an electrode on the suprasternal notch and the other on the left mid-clavicular line at the level of the xiphoid.

8. Rub the electrodes on the skin to work in the jelly and insure good contact.

9. Press electrodes firmly (8 to 10 pounds) against the chest and step on the foot switch.

10. In case of failure to defibrillate, press the electrodes more firmly against the body and step on the foot switch again.

11. If the defibrillated heart is to resume a normal beat spontaneously, A.C. defibrillation must be applied promptly, preferably within 2 minutes of the onset of fibrillation.

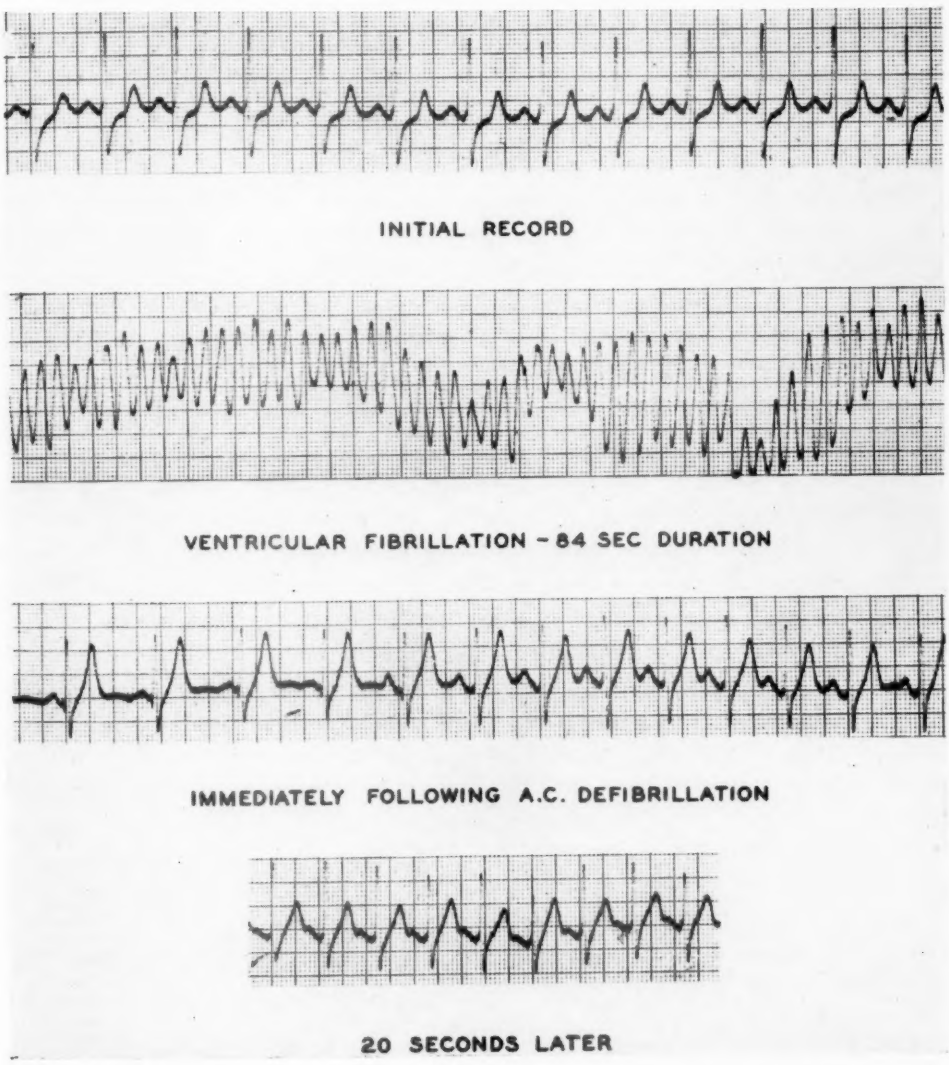

Fig. 5.—Electrocardiograms (Lead II) from an 18-year-old girl, in whom ventricular fibrillation developed during cardiac catheterization and was successfully terminated with the external defibrillator. The upper strip shows the control record just prior to catheterization. Ventricular fibrillation started while blood samples were being taken from the right ventricle. The lower strips are cardiograms taken during the first minute following defibrillation.

SUMMARY

This paper presents the results of a study of closed chest methods of defibrillating the ventricles. The most reliable defibrillating stimulus was found to be a single continuous application of about 5 amperes of 60-cycle alternating current for a period of 0.25 second in the direction of the long axis of the heart through electrodes on the chest. Equipment developed for this purpose for hospital use is described.

When ventricular fibrillation has been present for less than 2 minutes, application of this method results in defibrillation and survival in a high proportion of cases. If ventricular fibrillation persists for more than 2 minutes, defibrillation is still possible in the majority of cases, but is often followed by cardiac standstill and death unless thoracotomy and manual cardiac massage are carried out.

Effective use of the method of closed-chest defibrillation in the operating room or emergency ward requires that the necessary equipment be available and promptly applied.

ADDENDUM

Since the completion of this manuscript the external defibrillator described has been used on 2 patients with successful termination of ventricular fibrillation in both instances. In neither case was the chest opened.

The first patient was a 72-year-old man with arteriosclerotic heart disease, complete heart block, and Adams-Stokes attacks due to ventricular fibrillation. Over a period of 4 days, 10 such attacks were terminated by the external defibrillator. After the tenth defibrillation the heart remained in standstill and the patient died.

The second patient was an 18-year-old girl with tetralogy of Fallot, on whom a left subclavian-pulmonary artery anastomosis had been performed at the age of 6 years and a similar right-sided anastomosis at the age of 11. During the course of cardiac catheterization ventricular fibrillation appeared (Fig. 5). The catheter was immediately withdrawn as far as the peripheral vein, the defibrillator electrodes applied, and a defibrillating shock given 70 seconds after the onset of fibrillation. Since the electrocardiograph was temporarily paralyzed after this shock and no arterial pulse could be felt, a second defibrillating shock was given 14 seconds later. Normal sinus rhythm reappeared immediately, and the patient regained consciousness within a few seconds, saying she "must have fallen asleep." She was discharged from the hospital 3 days later, with no apparent ill effects from the fibrillation or the defibrillating procedure.

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Editorial

CONDUCTED BY I. S. RAVDIN, M.D.

The Medical Profession, Health Insurance, and the Medical Schools

The rapid growth of health insurance since World War II has upset traditional patterns in American medicine. Relations of practicing physicians with medical schools, hospitals, and insurance plans are confused and, in places, unfriendly. The attainment of the high purposes of these guardians of the nation's health requires cooperation among them, unhampered by hidden conflicts. Areas of disagreement need analysis and frank discussion. The views to be expressed are the purely personal ones of a practicing surgeon who is a part-time member of a medical school faculty and a Blue Shield adviser.

It is hard to define the issues and risky to generalize about them, for there is not one medical school; there are over 80, each with different needs and administrative attitudes. The medical profession speaks through national and local societies, but these can hardly voice the separate opinions of 200,000 doctors—all with individual experience and views. In the insurance field there are some 75 Blue Shield Plans, many with multiple types of programs, and over 800 commercial companies. No one dean, no one doctor, no one Blue Shield administrator can speak for all his colleagues.

The medical schools struggle with special problems in obtaining proper teaching staffs, in attracting students of fit character and ability, and in getting financial support. For these institutions "tight money" did not begin in 1956, but many years ago. Each school has tried to reach all available sources of funds; most are short of meeting reasonable needs. All are threatened by a falling off in the quality of applicants should medicine become a less satisfying profession.

Blue Shield Plans vary widely as to size, financial stability, extent of benefits provided, and helpfulness to the profession and the public. Membership growth has mushroomed in the past decade; growth has been so fast that adequate consideration of benefit schedules and of their effect on medical practice has sometimes been slighted. That the Plans have not done worse is creditable. And it is to the credit of the practicing physicians that, in most areas, they conceived and have loyally supported these Plans through a difficult and fast-changing infancy.

The medical profession itself is in a state of some unrest and change. Well documented are strained relations between the doctor and his colleagues, hospitals, Blue Shield, medical societies, governmental bodies, specialty boards, and neighboring medical schools. Group jealousies among men in general practice, internists, surgeons, and other specialists are not always beneath the surface. But to recognize these stresses is not to say that the situation is serious or that radical changes should be pushed. The overwhelming majority of doctors continue to care conscientiously for the sick, to protect the well, and to treat their colleagues with consideration.

It is no wonder that three surging and heterogeneous agencies of the people's health—the medical schools, Blue Shield Plans, and the practicing doctors—should have areas of unhappiness with one another. The doctor is irritated by the necessary requirements and inherent limitations of the prepayment plans. He is suspicious that Blue Shield will unduly influence the practice of medicine. He finds fee schedules and benefit patterns that are unrealistic or out of balance because of the persuasive power or undue dominance of particular specialty groups. Many of his complaints and concerns are justified. It is essential that the medical societies keep control of Blue Shield development, working through their appointees to Blue Shield Boards of Trustees. The societies should assign to these Boards medical statesmen, men of highest caliber and broadest view, capable of recognizing and resisting unjust demands of narrow groups.

The doctors also may be apprehensive about trends in hospitals and medical schools. Some are increasingly concerned with payments by Blue Shield and insurance companies for services rendered to patients by resident staff physicians. Resolutions on this subject have been adopted by local medical societies and national organizations. Recently restrictions have been incorporated in public law.* In some localities this issue is charged with high emotion. It needs calm evaluation. It brings into focus the twofold dilemma of the medical schools: first, they must have patients with whom to train the doctors of the future; second, they must not drift further into bankruptcy.

Consider briefly these two problems. The charity patient is fast disappearing, in some regions has just about gone. National prosperity and health insurance have put the former indigent into the category of the paying patient. This decimation of the public ward patient group threatens the residency training system, which is the most effective element of modern graduate medical education—threatens it not only with deterioration, but annihilation. So the important issue is not so much that the schools are sidetracking patients from private practitioners; it is more that the ward or service patients formerly available as teaching subjects of the schools are now paying patients. As a resident surgeon a decade ago I operated upon public ward patients who in

*Dependents Medical Care Act of 1956 (Public Law 569—84th Congress).

these days pay, partly through insurance, a customary professional fee for personal or family illness. This is an experience shared by thousands of physicians.

The second problem of the medical schools—insufficient funds—is likewise getting worse. Solutions may be sought in three directions: first, increasing dependence on the government, deplored by most of the profession; second, the schools might be subsidized by the members of the medical profession and by industry through direct donation (this is a useful but thus far inadequate source of support); and third, the schools or affiliated hospitals may collect fees for professional services rendered in the course of their teaching function. These fees may be insurance payments on behalf of patients who were treated free by the university hospitals a few years ago. The schools may thus become the beneficiaries of fees from patients who apply to university hospitals for care. We must remember that patients exercise free choice in seeking treatment under university auspices.

Where fees are involved there will always be discussion about principle. And such discussion may lead to action with far-reaching effects. Consider a challenge confronting four hospitals on the eastern seaboard: The Massachusetts General, The Grace-New Haven Hospital, The New York Hospital, The Johns Hopkins Hospital; others could be listed. These are major teaching facilities of the medical schools of Harvard, Yale, Cornell, and The Johns Hopkins Universities. For decades the training offered at these institutions has been sought by some of the best graduates of American medical schools. No one who deeply considers the record and promise of these teaching centers should wish to hamper them. Yet each is laboring under difficulties, and at least one is actually handicapped in its functions by restrictions on payments by Blue Shield. The majority of practicing physicians will be quick to respond to an attack on medical freedom or on educational freedom, where undisguised. It is harder to disentangle the issues where problems of custom and ethics become involved with education.

In the State of Maryland, there are two medical schools and some 2,200 physicians in private practice. Most of the 2,200 doctors graduated from one or the other of these two schools; they continue to benefit by association, by help with patients, and to enjoy postgraduate opportunities offered by these schools. Resident physicians of the hospitals that are a part of these two universities earned in 1956 some $128,000 for services to Maryland Blue Shield subscribers. Can it be argued that the carefully supervised practice of medicine by these university resident staffs, essential to their postgraduate training and to the provision of qualified practitioners for the future, constitutes a serious threat to the private practice of medicine? If $128,000 were divided among the practitioners of the state, each doctor would be about $60 richer. Would even doubling or trebling that amount constitute a threat to the security of the practitioner? All agree that doctors should be paid for their services. Is it wrong to pay for professional service which is provided incidental to educating young doctors?

Parenthetically, consider the concern expressed in some regions over the practice of medicine by salaried university professors. This apprehension should be seen in its true proportions. Two dozen competent practitioners could care for all the local private patients now being treated by the full-time academic men in Maryland. Faculties cannot work, cannot teach, in a medical vacuum. Alert as the profession must be in guarding its freedom, it must be just as intent on maintaining the freedom of its teachers. Academic independence and medical progress go together. The phrase "go together" is used advisedly. It is narrow to consider the full-time system vicious or to consider it sacred and above improvement.

Of course, academic independence does not mean academic isolation. So far the curricula of many medical schools contain no hint as to how modern medicine is made available to the ultimate consumer or how he pays for it. It is not clear that the people in the schools have everywhere accepted their responsibilities in the medical community or have labored enough to extend advances in medicine beyond the teaching centers.

There is no quick solution to the problems mentioned or the conflicts outlined in the foregoing remarks. Practical suggestions must be rather general. Between the schools and local medical societies more liaison could lead to better understanding and cooperation. For instance, meetings between society councils and university deans should be held on a regular basis to exchange views and information. Representative practitioners should be invited to the national meetings of the Association of Medical Colleges. Postgraduate courses for practitioners should be encouraged. Faculty members must take an intimate interest in the workings of their local medical society. The societies must be sympathetic to the needs of the schools for clinical material and financial support. Both the schools and the profession must recognize that the public is demanding prepaid health insurance. Both must assume responsibility in understanding and in guiding this new health service.

At the National Conference of Blue Shield Plans in March, 1957, I sponsored a resolution authorizing the Blue Shield Commission to set up a committee in cooperation with the American Medical Association and the Association of American Medical Colleges to study and report on the effect of prepaid health insurance on medical education. It is hoped the deliberations of this committee will produce better understanding and better plans for making medical care, prepayment, and education a happier and more effective trinity. Blue Shield should be vitally interested in medical education; the quality of its sales product tomorrow depends on the excellence of medical training today.

The multiplicity of insurance programs is unsettling, but lessons are being learned every day. We know that there is little pioneering or discovery in a completely orderly situation. This is no time to force medical practice, insurance progress, or educational development into rigid molds. Experimentation and evolution will gradually point the way. Freedom to experiment within the bounds of honesty and good sense must not be limited—not in the laboratories, nor in the wards, nor in the equally complex fields of medical economics,

professional policy, and education. On the other hand, freedom to criticize experiments before, during, and after their performance is the right of all responsible men and should be acknowledged gracefully by those who sponsor changes.

—William E. Grose
Department of Surgery
The Johns Hopkins University
School of Medicine
Baltimore 2, Md.

Appraisal of Progress in Surgical Therapy

CONDUCTED BY WARREN H. COLE, M.D.

LUMBAR SYMPATHECTOMY IN THE TREATMENT OF OBLITERATIVE VASCULAR DISEASE OF THE LOWER EXTREMITIES

REGINALD H. SMITHWICK, M.D., BOSTON, MASS.

(*Continued from August issue*)

RESULTS TO BE EXPECTED FOLLOWING SYMPATHECTOMY OF EXTREMITIES FULFILLING CRITERIA OUTLINED

Effect Upon Circulation of Foot and Toes.—To give an approximate idea of what may be expected, I have reviewed the outcome in 100 extremities which were studied as I have outlined and fulfilled my criteria for sympathectomy. They are not consecutive cases because in spite of my desire that every case under my supervision be studied in the fashion I have described before operation, these data were not always obtained. Nevertheless, the statistics show quite clearly that the really poor results following sympathectomy can be largely avoided.

The effect of sympathectomy upon the circulation of the distal portion of an extremity is illustrated by Table III.

TABLE III. EFFECT OF SYMPATHECTOMY UPON THE CIRCULATION OF THE FOOT AS JUDGED BY SKIN TEMPERATURE STUDIES AND PLETHYSMOGRAMS

PULSE TYPE	NUMBER OF EXTREMITIES	IMPROVED	NOT IMPROVED	RESULT UNKNOWN
I	13	13	0	0
II	32	28	2*	2
III	50	48	1†	1
IV	5	5	0	0
Totals	100	94	3	3

*These are the 2 extremities having leg amputations in spite of the fact that the circulation was markedly improved prior to amputation for 15 months and 2 years, respectively.

†Died 6 months postoperatively.

Improvement in the circulation of the foot and toes is the rule following lumbar sympathectomy for obliterative vascular disease if the necessary criteria are present prior to operation. This effect is maximal immediately after operation.

Localized Ulceration or Gangrene.—Among these 100 extremities were 29 having localized ulceration of toes or the distal portion of the foot or impending

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or actual gangrene usually of toes. In 20 the lesions healed following sympathectomy. Three of these extremities were in pulse type I, 9 in pulse type II, 7 in pulse type III, and one in pulse type IV.

Minor Amputations.—Minor amputations were necessary in 9 extremities and were performed at the time of sympathectomy or shortly thereafter. The distribution of these extremities among the pulse types is indicated by Table IV. In 4 extremities, toe amputations were performed in pulse types I and II. All were successful. Also, one transmetatarsal amputation in a pulse type II extremity was successful. Three toe amputations were done in pulse type III extremities. One was successful and 2 failed but were followed shortly by successful transmetatarsal amputations. There was one successful primary transmetatarsal amputation in this pulse type category. Thus 11 minor amputations were performed in 9 extremities, 7 being successful primarily and 2 secondarily. No major amputations were performed in any of these 100 extremities during the hospital admission for sympathectomy. In all of these 9 extremities, it was obvious prior to sympathectomy that an amputation of some sort would be necessary because of the extent of the ulceration or gangrene.

TABLE IV. MINOR AMPUTATIONS FOLLOWING LUMBAR SYMPATHECTOMY

PULSE TYPE	TOE OR TOES	METATARSAL
I	1	0
II	3	1
III	3	3
IV	0	0
Totals	7	4

Major Amputations.—A major amputation was eventually performed in 2 of these 100 extremities. One of these patients had bilateral popliteal aneurysms at the time of sympathectomy. He did very well for 2 years and then suffered a sudden embolic occlusion distal to the aneurysm presumably from a mural thrombus. This was followed shortly by spontaneous thrombosis of the aneurysm with the development of gangrene of the distal one-third of the foot. A successful Syme's amputation was performed which is functioning very well. While in the hospital, the aneurysm of the other leg thrombosed spontaneously and asymptomatically.

The other patient was sympathectomized bilaterally for cold, cyanotic, numb extremities with impending gangrene and intermittent claudication of moderate severity. Both extremities had type II pulses. The patient did very well for 15 months. At that time, she had a sudden thrombosis of the left femoral artery and developed gangrene of her great toe extending proximally onto the dorsum of the foot. A transmetatarsal amputation was attempted through the proximal portion of the tarsal bones and failed. A Syme's amputation would probably have been successful. Later, a point of election amputation below the knee was performed elsewhere and was successful. No thigh amputations were necessary.

Effect of Sympathectomy Upon Intermittent Claudication.—Intermittent claudication of mild to great severity was present in 70 of these 100 extremities.

The effect of sympathectomy is known in 68 extremities. The results are summarized in Table V. They are based upon the opinions of the patients as to the effect of operation upon their walking capacity.

TABLE V. SYMPATHECTOMY AND INTERMITTENT CLAUDICATION

PULSE TYPE	NUMBER OF EXTREMITIES	IMPROVED	UNIMPROVED	UNKNOWN
I	7	7	0	0
II	16	15	1	0
III	42	29	11	2
IV	5	0	5	0
Totals	70	51	17	2

Slight to marked improvement was the rule in pulse types I and II. Of 7 type I extremities, the improvement was graded as slight in 5 and moderate to marked in 2. Since all main vessel pulsations are present in these extremities it is doubtful if direct surgery would often be indicated. Much the same can be said of patients in pulse type II, where the improvement was moderate to marked in 10 and slight in 5 of 16 extremities. In only one there was no improvement. All of these patients have palpable popliteal pulsations. In spite of this, localized areas of occlusion proximal to this level may be present and might be amenable to direct surgery. However, since the statistical chance for some degree of improvement in walking capacity following sympathectomy is greater than the statistical chance that direct surgery will be successful, I prefer to sympathectomize the extremity and defer the decision regarding direct surgery until the outcome is known.

The largest group of all is that with patients having type III pulses. The walking capacity of 29 of 42 extremities was improved slightly in 8 and moderately to markedly in 20. In 12 there was no improvement and in 2 the outcome is unknown. In all of these extremities the femoral pulse is present and the popliteal is absent. Thus occlusion of the femoral artery is present in all and, without doubt, some might benefit a great deal by direct surgery. The response to sympathectomy may, however, be dramatic or good enough that direct surgery would seem unnecessary. Since the chances are about 2 out of 3 that some improvement will follow sympathectomy, I prefer also in these cases to defer the decision regarding direct surgery until the outcome is known. In the meantime evidence is gradually accumulating which I hope will enable one to predict the effect of sympathectomy upon claudication with as great accuracy as we can predict what the effect will be upon the circulation of the foot.

There were only 5 extremities in pulse type IV. Here the results were striking in that none of the patients noted any improvement in walking capacity. This has been my experience with other similar extremities in the past. Rarely, if ever, will lumbar sympathectomy help extremities of this sort with the exception of the circulation to the leg and foot. Also, these patients have the most severe type of claudication usually affecting the gluteal and thigh muscles in

particular. They frequently have localized occlusion of the iliac arteries sometimes involving the distal aorta with patent and fairly respectable vessels distally. Ischemia of the foot is the exception rather than the rule. Also, the chances that direct surgery will be successful is greater in this group than in any other, since one is dealing with vessels of large diameter. For these reasons, the direct approach should be utilized whenever feasible in patients falling into this pulse category. Sympathectomy is of secondary importance except in an extremity with ischemic symptoms. If the circulation of the foot is precarious and the criteria for sympathectomy are present, I would perform the sympathectomy first and approach the lesion directly later. Otherwise, direct surgery should be done primarily. Since I am impressed by the protection which sympathectomy offers against future gradual or sudden occlusive episodes and since we are dealing with a progressive disease, the course of which is unpredictable, I feel that sympathectomy should be performed in conjunction with direct surgery. Fig. 7 illustrates the usual outcome in an extremity of this sort in which sympathectomy was followed by a marked increase in circulation to the foot with no improvement in claudication. The latter was relieved by subsequent direct surgery, endarterectomy in this particular case.

DISCUSSION

The results of lumbar sympathectomy for obliterative vascular disease vary as judged by representative reports in the literature. This is due basically to the lack of a uniform method of selecting patients for operation. Yeager and Cowley[18] reported upon a series of 150 patients. They considered 31 per cent to be improved following operation. In 73, no preliminary studies designed to aid in the selection of patients were employed and 77 had what were regarded as minimal vasomotor studies. Forty-three major amputations were performed within 2 months following ganglionectomy. The operative mortality was 5.5 per cent. An equal number of patients died within a month of operation. The authors stress that operation should be reserved for those cases in which there is a reasonable chance of success to avoid casting doubt upon an otherwise effective procedure. They concluded that "lumbar sympathectomy adequately executed, in properly selected cases of organic peripheral vascular disease, is an adjunctive procedure of merit." With this, few would disagree. That is the reason why I have gone into considerable detail in presenting a method for the selection of patients for operation since the results which can be expected differ greatly from those just referred to.

Nelson and Trimble[12] recently reported their results of lumbar sympathectomy in a series of 192 patients representing 272 extremities. These results also stand in sharp contrast to those which I have indicated may be expected if certain criteria are fulfilled. They conclude, in essence, that "predicting the result of operation for an individual patient has been impossible by any clinical or laboratory procedure used for preoperative evaluation. . . ." "Poor results are noted in 59 to 74 per cent of all patients with arteriosclerosis, arteriosclerosis complicated by diabetes mellitus, Buerger's disease. . . ." These are the types

of cases which I have discussed. They urge "that in the light of these results, a more vigorous attempt be made to screen patients for possible direct attack on the offending occlusion." Another recent critical evaluation of lumbar sympathectomy by Berry, Flotte, and Coller[2] also gives one the impression that the operation leaves much to be desired. They reported upon 391 lumbar sympathectomies in 275 patients. Good results were obtained in 34 per cent and poor results without amputation in 20 per cent. One hundred and seven major amputations were performed on 119 patients and 108 patients died, the average survival time being 25 months. One-third lived less than one year. They favored bilateral operation when the condition of the patient permitted.

In these reviews are few suggestions regarding ways and means of selecting patients who will do well following sympathectomy. Some good results were obtained in all 3 series but in the minority of extremities subjected to operation. Berry, Flotte, and Coller, however, did attempt to state the circumstances under which the likelihood of a good result was poor. These were (1) elderly diabetic persons (over 65 years of age) with clinical evidence of arteriosclerotic involvement of other organs or elevated systolic blood pressure, (2) severe atrophy of the soft parts of the leg with evidence of marked capillary anoxia, (3) severe pain involving the foot or lower third of the leg with absent popliteal pulses, (4) a rapidly progressing process with widespread arterial involvement, and (5) gangrene or ulceration involving the foot in patients over 60 years of age with severe pain and obliteration of the popliteal pulses.

I have already referred to the fact that arteriosclerosis is the major problem and that involvement of other vascular areas, especially the heart and the brain, may compromise the result of treatment of peripheral vascular disease by any method. This comment refers to the first suggestion of Berry, Flotte, and Coller. With regard to suggestions 2 through 5, inclusive, I am quite certain that few if any of the extremities in these categories would have a flushing time of 20 seconds or less and, consequently, should be regarded as poor candidates for sympathectomy.

The reports just referred to emphasize the fact that the longevity of many patients with peripheral vascular disease needing treatment is not bright. That of Edwards and Crane[8] confirms this fact. Thirty-five per cent of their patients were dead 5 years after sympathectomy.

Sympathectomy offers more to patients in pulse type categories I, II, and III than does direct surgery, not only on the basis of my experiences but also upon the evidence in the literature. Only in pulse type IV is direct surgery indicated in almost every instance. If one could predict the effect of sympathectomy with greater accuracy in patients with pulses in type III or the result of direct surgery in these same patients, then the problem of what to do about a particular extremity would be largely solved. I am hopeful that the routine studies which we now employ together with arteriograms and plethysmographic studies of blood flow to the calf muscles will before long give a more accurate answer to this as yet unsolved question.

Predicting the Effect of Sympathectomy Upon the Circulation to the Foot and Toes.—With regard to predicting the effect of sympathectomy upon the circulation to the foot and toes, the method of study which has been outlined is satisfactory, accurate, and preferable to that suggested by Cranley and associates[6] who found an excellent correlation between the skin temperature of the great toe 3 to 39 months after operation with that noted during operation under ether, cyclopropane, or spinal anesthesia. That does not help with the problem of selecting patients for operation. No method of study which they had employed prior to operation was sufficiently accurate to predict the effect of sympathectomy upon the circulation to the foot and toes, in their experience.

The method of study presented makes use of both skin temperature studies and plethysmograms. It takes advantage of the good features of each method and recognizes the shortcomings of both. Goetz[9] depends primarily upon information derived from digit plethysmography and feels that a satisfactory outcome following sympathectomy can be predicted with reasonable accuracy on the basis of this information alone. He places emphasis upon the demonstration of a significant increase in arterial inflow to the digit during venous occlusion and finds that even in the presence of a nonpulsatile digital blood flow that observations of this sort are helpful in predicting the outcome following sympathectomy. Since, according to his observations, extremities having a nonpulsatile flow are surviving on a collateral circulation, an increase in arterial inflow during venous occlusion indicates an adequate collateral and in general means that the result of sympathectomy will be worthwhile. Cranley and coworkers,[4] on the other hand, find that inherent difficulties in the measurement of digital blood flow by the venous occlusion method make it less practical than the study of digital pulsations for routine laboratory use. Fig. 5 is a particularly good illustration of the value of skin temperature studies in the presence of a nonpulsatile digital blood flow.

Predicting the Effect of Sympathectomy Upon Intermittent Claudication.—While the effect of sympathectomy can be predicted with accuracy upon the circulation of the foot and toes, it can be predicted with only reasonable accuracy as far as the circulation to muscles is concerned. Many who have struggled with this problem emphasize the fact that the most important consideration in the treatment of peripheral vascular disease is to prevent a major amputation. This depends upon an improvement in the circulation to the distal portion of the extremity.

It so happens, that patients who are suitable candidates for sympathectomy with reference to the distal circulation also stand a very good chance for slight to marked improvement in walking capacity. Of the 100 extremities reviewed in connection with this report, all of the extremities in pulse type I were improved and 15 of 16 extremities in pulse type II could walk better after sympathectomy. In the majority, the improvement was moderate to marked and in some it was spectacular. Even in pulse type III (femoral present, popliteal absent) 2 out of every 3 extremities were improved in a similar fashion. Only in pulse type IV (femoral absent) was no improvement in walking capacity the rule.

While it is possible that more detailed studies of muscle blood flow by plethysmography combined with routine arteriography, reported by Beaconsfield,[1] will help in predicting the effect of operation upon intermittent claudication with greater accuracy, the chances for improvement in patients who fulfill the criteria which I have outlined are already greater than they are following direct surgery with the exception of those in pulse type IV. In this respect, my experiences are quite the same as those of Goetz.[9] It is for this reason, among others, that I still favor sympathectomy as the primary approach to peripheral vascular disease in patients who fulfill the criteria I have outlined who are in pulse categories I, II, and III. The chances for improvement of a sufficient degree in walking capacity are so good that only a rare patient is interested in considering direct surgery to further improve his walking capacity after sympathectomy, especially when he is acquainted with the statistical chances for success.

The principal reason why it may never be possible to predict the effect of sympathectomy upon intermittent claudication with the same accuracy that one can foretell its effect upon the circulation to the foot and toes is that a time factor is involved. In the great majority of cases, the walking capacity is not improved for months to even a year after operation. It is therefore dubious if any acute physiologic observation made prior to operation can always foretell what will happen to the circulation to the muscles with the passage of time. Nevertheless, it is worthwhile to pursue any line of investigation which will increase the accuracy of prediction in this regard beyond that which already exists. In patients who are ideally suited for direct surgery, the latter should be recommended after the result of sympathectomy is known to be unsatisfactory, severe incapacitating claudication persists, and the general condition of the patient warrants it. At this time, direct surgery should be the primary approach only in patients with type IV pulses (femoral absent). Among those with type III pulses (femoral present, popliteal absent) will be patients who will stand a good chance for improvement following direct surgery if conditions are ideal for it. If it could be stated with accuracy at this time that the result of sympathectomy upon intermittent claudication would not be satisfactory, then direct surgery could be undertaken at the time of sympathectomy in such cases as suggested for those having type IV pulses.

Indirect (Sympathectomy) Versus Direct Surgery.—During the past 30 years, I have had the opportunity to observe a number of patients with pulseless extremities who were asymptomatic and therefore entirely unaware of the presence of extensive obliterative vascular disease. In other words, it is possible for the collateral circulation in an extremity to develop to such a point that it adequately replaces main vessel circulation. Sympathectomy, according to most observers, affects the collateral circulation primarily and any benefit which follows this procedure is largely dependent upon the gradual development of collateral channels. Sympathectomy affects the entire vascular supply of an extremity, not just a localized segment. There is abundant evidence in my experience as well as in that of others that it affords great protection against subsequent main vessel occlusion whether the latter be gradual or sudden in

onset. Presumably, it facilitates the development of the collateral circulation more rapidly and more completely than otherwise would be the case. This is the reason why I firmly believe that sympathectomy should be performed in every patient having signs and symptoms of obliterative vascular disease if the criteria for operation which I have mentioned are met.

My philosophy in this connection is shared by others and is well expressed in the first conclusion of Cranley, Hermann, and Preuninger,[5] "the existence of patients with minimal evidence of arterial insufficiency despite complete occlusion of the major vessels of the lower extremity demonstrates the potential efficiency of the collateral arterial circulation and demonstrates as well that, clinically speaking, arteriosclerosis obliterans does not invariably lead to complete ischemia, but instead, the circulation of the limb may even improve as the collateral circulation is developed. Since this is so, it seems best to direct the attention to methods of increasing the efficiency of the collateral circulation rather than to attempt to remove or by-pass localized areas of obstruction in an arterial tree which is diffusely involved in the obliterative process." The course of the right extremity in the case illustrated by Fig. 6 is a particularly good example of the protection afforded by sympathectomy in the presence of progressive occlusion of the main vessels. At the same time, the circulation in the unsympathectomized left leg was deteriorating as main vessel obliteration increased.

During the past 30 years, I also have had the opportunity to observe a considerable number of extremities in which the circulation to the distal portion of the extremity was impaired or walking capacity slightly to markedly reduced when all main vessel pulsations were present. Here the problem would seem to be not primarily with the main vessels but with the smaller arteries and arterioles to skin and muscle. These are the patients who have type I pulses. Direct surgery would hardly seem indicated, yet sympathectomy invariably results in improvement in the distal circulation as well as in walking ability. When the popliteal artery pulsates and the obliterative process has eliminated one or more of the pulses distal to this level (type II) the chances for improvement following sympathectomy in properly selected cases are so great that direct surgery is not indicated as the initial procedure.

The success of direct surgery is dependent upon the removal of a localized area of occlusion in a major artery of an extremity. It is not primarily dependent upon the development of the collateral circulation for success. In fact, the presence of an area of complete occlusion in a main artery is a stimulus to the development of collaterals. Removing the block also removes this stimulus. In other words, direct surgery is an entirely different approach to obliterative vascular disease. It is not a substitute for sympathectomy but another valuable adjunct in the management of a difficult problem. The intelligent surgeon will employ both methods of treatment, as indicated.

Interest in the direct approach to this problem has been great in recent years and the literature on this subject is voluminous. It will be many years before the last word can be said about the selection of cases for direct surgery

and the late results evaluated. It is already obvious that direct surgery is most likely to succeed when one is dealing with the larger arteries, when the occlusion is well localized, and the main vessels proximal and distal to the occlusion are patent and not diffusely involved in a degenerative process. In other words, when the occlusion involves the lower aorta or common iliac arteries and is well localized with good distal arteries, the chances for success are very great, provided the general condition of the patient is such that an operation of this magnitude can be tolerated. Endarterectomy is to be preferred whenever the thrombus can be readily removed. If calcification involves the entire wall of the artery, excision and grafting are indicated. The case illustrated by Fig. 7 is an excellent example of the ideal case for direct surgery (pulse type IV). Under such circumstances, the chances for a successful outcome are in the region of 90 per cent.

It is apparent that the largest number of patients presenting themselves for treatment (50 per cent) are those who have femoral pulses with all pulses distal to that level absent. In many, the main vessels are patent and fill via collaterals but are obviously badly diseased and not suitable for direct surgery. However, they may respond surprisingly well to sympathectomy. Others have localized occlusions, which are not too extensive, with good vessels proximally and distally and are therefore ideally suited for direct surgery. Such cases may also do surprisingly well following sympathectomy. The right extremity in Fig. 6 is a particularly good example of this. When first seen there was a short segment of complete occlusion in the lower third of the femoral artery. A sympathectomy was performed. Thirty months later, the patient was almost asymptomatic, the femoral pulse had disappeared, and the right common iliac artery was completely occluded. What would have been the result if the patient had not been sympathectomized and the occlusion of the femoral artery had been treated either by endarterectomy or grafting? While the greatest opportunity for direct surgery is in patients having type III pulses, sympathectomy should be the primary procedure, when indicated. Direct surgery can be done concomitantly if one is certain that the result of sympathectomy on intermittent claudication will not be satisfactory. Since no one can predict this and since the chances for improvement in walking ability following sympathectomy are 2 out of 3, I prefer to reserve direct surgery for cases ideally suited for it in whom the effect of sympathectomy is not adequate.

The results of direct surgery involving the femoral artery are not as good as when the aorta or common iliac arteries are involved. With the passage of time they appear to be deteriorating further for various reasons. Just what the statistical chance for success really is is quite speculative. It can be as low as 50 per cent, perhaps even 25 per cent.[14, 15] The early results might be good in a high percentage of cases if rigid criteria for selection are employed, and especially if endarterectomy can be done in preference to grafting. The early results of grafting or endarterectomy may be comparable but the later results of endarterectomy appear to be better.[3, 11, 17] Crawford and associates[7] found that slightly more than 50 per cent of patients with femoral occlusions were

suitable candidates for grafting on the basis of arteriography. Their best results were obtained by the by-pass end-to-side technique where the obliterated segment exceeded 15 cm. Otherwise, the occlusive lesions were completely excised and replaced with arterial homografts. The early results were excellent in all but 3 of 24 by-pass operations and in 10 of 12 cases treated by excision and graft replacement. The causes of failure following grafting involve not only degenerative changes in the graft itself, but more frequently degenerative changes in the arteries distal to the graft and less frequently in the main artery proximal to the graft.[14]

One could philosophize about the question at some extent. Why, for instance, are we not discussing obliterative vascular disease of the upper extremities instead of the lower extremities? The answer is simple. Obliterative vascular disease of the upper extremities is extremely rare. The most likely reason why these patients have obliterative disease of the lower extremities and not of the upper extremities is that, because of the upright position of man, the intra-arterial pressure is higher in the arteries of the lower extremities for much of the time. It is of interest in this connection that following the relief of a main vessel occlusion by grafting the most common cause of failure is progression of vascular disease distal to the graft. These vessels are immediately subjected to a higher pressure. In the meantime, vascular disease proximal to the graft continues to progress. Why then do the late results of endarterectomy appear to be better than after grafting maneuver? Grafting, either by end-to-end or end-to-side techniques may have an unfavorable effect upon the collateral circulation. Endarterectomy, on the other hand, reopens collateral channels and this protects the main vessels distal to the area in question from the full impact of restored main vessel circulation. Also, the continuity of blood flow is restored by remnants of the patient's own arterial tissues and not by autogenous venous, homologous arterial, or synthetic substitutes. The late results seem superior when endarterectomy is performed.

SUMMARY

1. A method of study has been presented whereby the effect of sympathectomy on the circulation to the foot and toes can be accurately predicted. The statistical chances for improvement in intermittent claudication in these same patients is recorded. It is excellent in pulse types I and II, good in pulse type III, and poor in pulse type IV.

2. Because of the progressive nature of the diseases in question, of arteriosclerosis in particular, emphasis should be placed on methods of treatment which affect the circulation of the extremity as a whole rather than concentrating upon an isolated segmental occlusion, which at one time may be important but which later may be of little consequence.

3. Sympathectomy should be performed in all cases having symptoms of arterial insufficiency where the criteria necessary to predict the outcome with reasonable accuracy are met.

4. Only in patients with pulse type IV should direct surgery be performed initially in conjunction with sympathectomy.

5. In all other suitable cases, sympathectomy should be performed (pulse types I, II, and III) to be followed later by direct surgery if symptoms warrant it, if the outlook for a successful result is good, and if the general condition of the patient justifies further surgery.

6. The late results of endarterectomy appear to be better than those following grafting procedures. To be successful, direct surgery must be performed under proper circumstances. Otherwise, the majority of the results are poor. The same can be said of the results of sympathectomy.

7. The results of sympathectomy in extremities which meet the criteria outlined in this report are good. They are to be contrasted with less satisfactory results referred to in the literature. The results of lumbar sympathectomy for obliterative vascular disease are almost entirely dependent upon the accuracy with which patients are selected for operation.

8. The criteria for sympathectomy referred to in this discussion are (1) an adequate collateral circulation as judged by a flushing time of 20 seconds or less, and, in addition, (2) a sufficiently active vasoconstrictor mechanism as judged by (a) an acceptable skin temperature group for the pulse category in question, (b) a reduction of 50 per cent or more in digital pulsations in the cool environment when compared with those noted in the warm environment, or (c) both.

9. The purposes of sympathectomy and direct surgery are different. One is not a substitute for the other.

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Reappraisal

CONDUCTED BY CLARENCE DENNIS, M.D. ASSISTED BY ALFRED HURWITZ, M.D.

LATE RESULTS OF URETEROSIGMOIDOSTOMY IN CHILDREN

A. J. MICHIE, M.D.,* AND C. EVERETT KOOP, M.D.,** PHILADELPHIA, PA.

(From the Children's Hospital of Philadelphia and the Harrison Department of Surgical Research, School of Medicine, University of Pennsylvania)

VOLUNTARY control of urination has been our goal in the treatment of exstrophy of the bladder. In all but one case, control of urination was achieved by ureterosigmoidostomy. In the exceptional case, because sphincter muscle was palpated beneath urethral mucosa, complete repair of the exstrophy and epispadias led to voluntary control of micturition.

METHODS

In the beginning the transplanted ureter was pulled through an oblique hole in the wall of the rectosigmoid and its distal end was fastened in the bowel lumen. The bowel wall was sutured in order to increase the length and obliquity but not to constrict the lumen of the ureteral tunnel; that is, a Coffey 1 ureteroenterostomy.

If the ureter was dilated, a No. 16 or 18 French latex urethral catheter was inserted into the ureter so that the eyes of the catheter were in the renal pelvis. The catheter was fastened to the ureter and both the catheter and ureter were passed through an oblique hole in the rectosigmoid. After the end of the catheter was pulled through the anus, the bowel wall was again sutured to increase the length of the ureteral tunnel; that is, a Coffey 2 procedure.

Recently the entire ureteroenterostomy has been performed through a midline incision in the bladder wall. A disc of bladder wall with the ureterovesical orifice in its center was cut from the bladder and was sewed as a patch in a hole in the lateral wall of the rectosigmoid; that is, the Maydl procedure.

In a patient with an exstrophy and an epispadias, a transverse ridge was palpated beneath the urethral mucosa near the verumontanum. Because this ridge would contract after mechanical stimulation a complete repair of the urinary tract defect was carried out.

All patients were given a sulfonamide for a 3-year period.

*Assistant Professor of Pediatric Surgery at the University of Pennsylvania and Attending Pediatric Surgeon at the Children's Hospital of Philadelphia.

**Associate Professor of Pediatric Surgery at the University of Pennsylvania, and Chief of Surgery at the Children's Hospital of Philadelphia.

RESULTS

Of the total of 21 ureters transplanted to the rectosigmoid by the Coffey 1 technique, a moderate dilatation was present in 3 (14.3 per cent) at the end of the first postoperative year (Table I). In one of these patients a renal stone developed and a nephrolithotomy was done. In all 3 cases the hydroureter was retransplanted to the rectosigmoid.

With the Maydl technique the degree of ureteral dilatation is less at 2 months than with the Coffey 1 procedure. However, one (12.5 per cent) of the 8 ureters transplanted by the bladder cuff method had to be retransplanted to the rectosigmoid by the Coffey 2 procedure. Thus, from the point of view of ureteral dilatation in our small series, the late results of the Maydl technique are not significantly different from those of the Coffey 1 procedure.

Following retransplantation to the rectosigmoid by the Coffey 2 technique, the caliber of the dilated ureter slowly diminished. The ureter contracted to a normal size in 2 patients in 3 years and sufficient time has not elapsed to evaluate the other 2 patients.

TABLE I. EXSTROPHY OF THE BLADDER

EFFECT OF SURGICAL TREATMENT ON THE URETERS					
			HYDROURETERS		
			2 MONTHS		
OPERATIVE TECHNIQUE	PATIENTS	TRANSPLANTED URETERS	MILD	MODERATE	12 MONTHS
Coffey 1	10	21	0	21	3
Coffey 2	4	4	0	4	4
Maydl	4	8	2	1	0
Complete repair of the urinary tract	1	2	0	2	0

A temporary but moderate degree of bilateral hydroureter occurred in the patient in whom the defective urinary tract was repaired. The dilatation was present only during the first 3 to 4 postoperative months and occurred in the absence of any direct ureteral manipulation. The ureters were normal in size and function by the end of the first postoperative year.

Probably because of continued sulfonamide therapy, only the patient with the renal stone showed signs of sepsis. Any pyelonephritis that occurred was minimal because urograms at 1 and 2 years after the operation failed to show any stigmata of this disease.

DISCUSSION

We were never able to demonstrate satisfactorily the cause of the stricture at the ureteroenterostomy site in our Coffey 1 transplants. This fact has led to a definite sense of insecurity in performing this procedure. On the other hand, the cause of the one failure in the Maydl procedure was devascularization of the bladder cuff causing necrosis and scarring of the ureterovesical orifice. We have continued to use this procedure because we understand the reason for our failure and because the degree of hydroureter is minimal in the immediate postoperative period.

We prefer to repair the defective lower urinary tract when our findings indicate that it may be possible to close a functioning urethral sphincter. When this cannot be done, we resort to ureterosigmoidostomy and rectal sphincter control of urination.

In the absence of a functioning urethral or rectal sphincter (we have not met this problem) we would repair the bladder and urethra. Then we would attempt to train the patient to credé his bladder as we do our patients with atonic cord bladders. We believe that the repair of the lower urinary tract defects is less hazardous and offers more advantages than the formation of an intestinal pouch into which urine drains and from which urine spills into a mechanical urinal on the abdominal wall.

SUMMARY

Ureterosigmoidostomy has been performed on 14 patients with exstrophy of the bladder. The hydroureter, which occurs in the immediate postoperative period, disappeared in all but 4 ureters in 4 patients. After retransplantation of the 4 hydroureters to the rectosigmoid, complete restitution occurred in 2 ureters and partial restitution in the other 2. The only other complication was a renal stone which was removed. There have been no fatalities and no nephrectomies.

While ureterosigmoidostomy was performed in most of our cases when the patient was 6 months old, no child over 3 years of age has failed to gain voluntary control of his cloacal sphincter.

In one patient we have succeeded in completely repairing the lower urinary tract defects. This patient has voluntary control of his urethral sphincter.

REAPPRAISAL OF ILEAL SEGMENT SUBSTITUTION FOR THE URINARY BLADDER

EUGENE M. BRICKER, M.D., HARVEY R. BUTCHER, M.D., C. ALAN MCAFEE, M.D., ST. LOUIS, MO.

(From the Department of Surgery, Washington University School of Medicine)

PREVIOUS publications pertaining to bladder substitution by the use of isolated segments of ileum have dealt with the technical aspects of the operation and preliminary reports of the functional results.[1, 3] Up to the present time we have performed some 175 ileal segment operations. This clinical material is now in the process of detailed study for another progress report. The last analysis of our material was published in 1954[3] and any factual statements in this appraisal will refer to that study and to a study on the results of pelvic exenteration published in 1956.[4]

This method of substitution for the urinary bladder has continued to prove satisfactory for our needs and has been used exclusively. The factors

of physiologic, mechanical, and technical simplicity have increased in importance with added experience with the operation. The ileal segment simply conveys the urine from both ureters to a convenient single external stoma by the shortest route possible. The use of an external appliance in the form of a glued-on bag has proved to be a practical, convenient, and sanitary substitute for an intra-abdominal reservoir.

As indicated by the 1954 study the mortality risk of the ileal segment operation has been 3 per cent when all operations are considered. The mortality risk of ileal segment bladder substitution alone or in association with lesser procedures than pelvic exenteration is considerably less than 3 per cent. These figures will be made current in the near future, but it is felt they will remain essentially as indicated in 1954. Similarly, pyelonephritis as evidenced by two or more attacks has occurred in not more than 20 per cent of the patients surviving 6 months or more. It is estimated at this time that less than 5 per cent of the patients have pyelonephritis of severe degree. The incidence of postoperative hydronephrosis has been low; 85 per cent of all renal units are normal or show minimal hydronephrosis 6 months after operation.

So far we have not recognized the complication of hyperchloremic acidosis. There is no reason it should not occur if the circumstances are right, that is, a long enough segment in a patient with some impairment of renal function. An occasional patient with a serum chloride at the upper limit of normal is the nearest we have come to recognizing this abnormality. The length of the ileal segment used is practically never longer than 6 to 7 inches.

The factors contributing to the results following ileal segment bladder substitution appear to be:

1. The mechanical and technical simplicity of the procedure makes it practical to combine with a major resection without staging. Operating time for isolating the segment, rejoining the bowel, and anastomosing the ureters averages 75 minutes.

2. Isolation of the segment from the fecal stream decreases the chance of ascending infection.

3. The wide open external stoma with the absence of a sphincter mechanism is thought to decrease the chance of back pressure and reflux up the ureters.

4. It has been found that the segments evacuate promptly through peristaltic action and are always in a relatively empty state. As a result, there is no stagnant reservoir of urine within which bacteria can multiply.

5. The method of ureterointestinal anastomosis by the "mucosa-to-mucosa" technique, which is aimed at primary healing with a minimum of scar tissue formation, is thought to result in a low incidence of obstruction and consequently in a low incidence of hydronephrosis and pyelonephritis.

6. Although absorption is known to take place through the mucosa of the segments they are so short that the amount of absorption of urinary constituents is of no clinical significance.[2]

Thus far the gratifying experience with this operation has led us to use it to the exclusion of all other methods of urinary diversion. We do not hesitate to apply the operation to benign lesions that are associated with incapacitating incontinence and feel the operation is especially indicated if incontinence is accompanied by a threat to renal function.

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TRANSESOPHAGEAL LIGATION OF BLEEDING ESOPHAGEAL VARICES

GEORGE CRILE, JR., M.D.,* CLEVELAND, OHIO

PATIENTS with portal hypertension who are bleeding from esophageal varices may be benefited by shunt operations. But many patients who bleed from varices do not have portal hypertension. At one time they may have had it, but the development of collateral circulation compensated for the block and hypertension no longer exists. The bleeding is from the fragile, thin-walled varices, that, whether or not hypertension is present, are filled with blood and may bleed as a result of trauma or erosion. During straining, the varices may rupture due to reflux of high-pressure blood from the valveless azygos system. In such cases it is difficult to see how shunt operations can prevent bleeding.

Transesophageal ligation is a simple and effective means of obliterating the varices. In patients with good liver reserve it carries a very low mortality and morbidity. In patients with extrahepatic blocks it has given definitive control of the bleeding in 6 of 9 cases for periods of time between 4 and 9 years. There have been no deaths and no serious postoperative complications. Three patients have bled again since operation; one bled mildly and intermittently for the first 2 years and not at all for the last 7 years; one bled from a proved gastric ulcer but has had no more bleeding since the ulcer was resected; and one bled from unknown causes. In the latter case re-exploration of the stomach and esophagus revealed no recurrence of the varices.

A similar group of patients with extrahepatic blocks have been operated upon in the past 4 years but have not been followed long enough for the results to be significant. In this group there have been no postoperative deaths or complications and only one minor episode of bleeding.

We have had little experience with transesophageal ligation in the treatment of intrahepatic blocks due to cirrhosis. Four patients whose livers were well compensated have been followed for 2 to 3 years since operation and have had no further bleeding. All patients who had jaundice or ascites from hepatic decompensation died following operation, usually with fistulas from failure of the esophagus to heal. Although Linton has reported good results

*Director of Surgery, Cleveland Clinic.

following ligation of varices in the emergency treatment of bleeding in patients with cirrhosis, we have not been able to reproduce his results in patients with decompensated livers.

In summary, transesophageal ligation of bleeding esophageal varices is as definitive as hemorrhoidectomy for bleeding hemorrhoids, carries a low mortality and morbidity, and appears to be the most effective operation for control of bleeding in patients whose liver function is good. In 9 years of experience with this method, no patient has died from hemorrhage or other complications.

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Surgical History

CONDUCTED BY JOHN R. PAINE, M.D.

EPONYMIC FRACTURES: GIOVANNI BATTISTA MONTEGGIA AND MONTEGGIA'S FRACTURE

LEONARD F. PELTIER, M.D., PH.D.,* KANSAS CITY, KAN.

(From the Department of Surgery, Section of Orthopedic Surgery, University of Kansas Medical School)

"La percossa di un bastone ruppe il cubito al terzo superiore e slogo' il raggio al lato, opposto."

A YOUNG woman fell upon her outstretched arm and was brought to the hospital where a diagnosis of a fracture of the ulna at the junction of the upper and middle third was made. The fracture was reduced and splints were applied. At the end of a month the dressings were removed and much to the embarrassment of the surgeon, upon extending the elbow, the head of the radius could be seen and felt prominently in the antecubital fossa. Upon flexing the elbow, the radial head could be replaced in a normal relationship, but it could not be maintained in position, redislocating immediately upon extension.

Such a case is not unusual and has occurred frequently enough to embarrass many surgeons. What makes this patient of special interest is that her surgeon was Giovanni Battista Monteggia who described her fracture in his *Istituzioni Chirurgiche*. As a result of his interest in these fracture dislocations and his description of them, such injuries now bear his eponym and are called Monteggia fractures.

As the opening quotation explains, these fracture dislocations commonly resulted from a blow of a staff or cudgel upon the forearm raised to protect the head. There is no reason to doubt that Monteggia had an ample experience with such injuries.

A Monteggia fracture is a fracture-dislocation of the elbow in which there is a fracture of the ulna in its superior portion with a dislocation of the head of the radius, either anteriorly or posteriorly (Fig. 1).

It is not unusual at this time to read papers or abstracts on surgical problems contributed by surgeons in Berlin, Prague, Belgrade, or Budapest. One

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*Professor of Surgery and Head, Section of Orthopedic Surgery, University of Kansas Medical School.

always wonders what sort of work can be carried out under disturbed conditions. Perhaps this review of the life and work of Giovanni Battista Monteggia is timely, for he taught, wrote, and practiced surgery in a time of great political turmoil and stress.

Before 1796 Lombardy was an Italian province ruled by the Austrians, and there was considerable local agitation for independence from foreign rule. When Napoleon entered Milan in 1796 at the head of a republican army, many patriots believed their hour of freedom had arrived. The Cisalpine Republic was formed in 1797 and one of Monteggia's professors and colleagues, Pietro Moscati, actually became president of the republic. The collapse of the French occupation was followed by the return of an Austro-Russian army in the spring of 1799. Napoleon returned to Milan again in June, 1800, and the Cisalpine Republic was reconstituted. After he was proclaimed Emperor of the French, Napoleon was crowned again in Milan on May 26, 1805, with the old iron crown of the Lombard kings. The Cisalpine Republic became the Italian Republic headed by Napoleon himself, but administered for him by Francesco Melzi, Conte d'Eril. The years of French occupation had a disastrous effect upon the economy of the region which had previously enjoyed prosperity. And, with the fall of Napoleon in 1814, Milan was reoccupied by the Austrians once again.

Fig. 1.—Roentgenogram of a typical Monteggia fracture, showing a fracture of the superior third of the ulna, with a dislocation of the head of the radius anteriorly.

As foreign soldiery, the camp followers and refugees swirled and eddied about the walls of the Spedale Maggiori in Milan, Monteggia maintained his incessant activity. It is hard to believe that he remained completely aloof from the political life in which his friends and colleagues were so deeply involved. However, his only recorded public office was as a member of the *Commissione per la vaccina* which helped to combat the scourge of smallpox.

In this capacity he made his observations on vaccinia-syphilis: "In vaccinating a syphilitic, a pustule is formed which contains the poisons of both vaccinia and syphilis. Both of the diseases can then be transmitted by inoculation to others."

Giovanni Battista Monteggia was born in Laveno on the shore of Lake Maggiore on Aug. 8, 1762. After receiving his early education in Pallanza, he enrolled, at 17, as a student of surgery at the Spedale Maggiore in Milan. After 3 years of study he passed the examination required for the practice of surgery. Somewhat later, he passed a similar examination in medicine.

He continued his work at the Spedale Maggiore where he became an excellent anatomist and performed many autopsies. His first published work, *Osservazioni anatomico-patologiche,* dealt with the differential diagnosis of diseases with symmetrical or asymmetrical findings as well as the management of parotitis, diseases of the thyroid, and the diagnosis and treatment of hernias. Because of his work, in 1791 he was made Instructor of Anatomy at the hospital. This was a position of some importance since, although Milan never boasted of a university of its own, being only 22 miles from Pavia, a course of lectures in surgical anatomy had been begun at the Spedale Maggiore as early as 1634. The advantage of the wealth of material for anatomic dissections had been realized, and this had developed into a regular school of anatomy by 1687.

His work in the dissecting room was not without hazard. One day while performing an autopsy on a patient who had died of syphilis, he cut his finger. Shorty afterward lymphangitis began, followed in a few days by a regular phlegmon. Recovery was slow, but 2 months later, after "only one episode of erysipelas" he finally regained the use of his arm. He was, however, infected with syphilis. One wonders whether his great interest in venereal diseases stemmed from this tragic accident. In addition to his own case, Monteggia also reported another similar instance in one of his students. In 1791 appeared an Italian translation of Fritze's work on venereal diseases translated and annotated by Monteggia. His own work, *Annotazioni pratiche sopra i mali venerei,* was published in 1794.

In 1795 Monteggia was called to Melzi's villa at Vaprio outside Milan to see a very important patient, Francesco Melzi, Conte d'Eril, who lay near death. The count's own physicians despaired of his life, but under Monteggia's care the count had a complete recovery. The count's letter of thanks to Monteggia is most interesting.

> Signor Monteggia, Gentilissimo:
> My gratitude is very large and in proportion to the zeal with which you cured me. But please do not think this gift is the real measure of my gratitude. With my gratitude is bound great esteem and deep affection for you, and the wish that you will never forget my feeling for you. To continually remind you of them, I am giving you an annual pension of fifty scudi. I feel obligated to do this, but it in no way obligates you. If you would like to use these funds for books from which you draw so much profit, I will be very happy, since I will be associated in some

way with the glory and progress of your career, and will enjoy the advantages which your fellow citizens derive from your increasing knowledge.

Your affectionate friend,

Francesco Melzi, Conte d'Eril

In addition to this pension, the count also retained Monteggia as his personal physician for a generous annual fee.

Successes such as this established Monteggia's reputation throughout Italy, and shortly thereafter he was appointed *Professore d'Instituzioni di Chirurgia,* a newly established chair at the Spedale Maggiori, a position which he held until his death.

Fig. 2.—Giovanni Battista Monteggia.

Apparently Monteggia used the annual pension for the purpose outlined by the Conte d'Eril, for throughout his subsequent publications there is continuous reference to the medical literature of Germany, France, England, and even the United States—books and journals, access to which may well have been denied him without this beneficence. His ability as a linguist allowed him to seize this opportunity and to make the most of it. None of these languages were foreign to him and his daily contact with the soldiers and émigrés thronging Milan abetted this natural proficiency.

In 1796 Monteggia published an annotated Italian translation of Stein's *The Art of Obstetrics,* and in 1806, a translation of the third edition of Fritze's book on venereal diseases.

In his role as *Professore d'Instituzioni di Chirurgia,* Monteggia presented regular lectures on surgical subjects (Fig. 2). It is not surprising therefore that in 1802 and 1803 he published them as *Istituzioni Chirurgiche.* As an introduction to these lectures he added a *Discorso accademico intorno allo studio della Chirurgia,* an address which he had given to his students. In it he summarizes his views on teaching and practicing surgery.

> "These formal lectures should be considered only as an introduction to a vast science; a foundation upon which the student should slowly build and enlarge for himself, without being satisfied with many of the doctrines enunciated here. Read the classics of the art of surgery! Abstract and take note of the best things which you find in these books so as to impress them upon your mind and make them readily available. Write and arrange all of your observations at the bedside and around the autopsy table. Do not limit your interest only to rare and strange cases, which are not always too clear, but pay attention to the common things. Record your observations as if you were the first man to write about such things. Correlate what you see with what you read and with your own reflections. The information derived from your own observations is the most essential means of perfecting our art. Amalgamate these diverse studies into a single science; theory united with practice. The stimulus for all of your work should be a desire for success, the voice of duty, but most of all the call of suffering humanity who await the help of your profession."

The first publication of these lectures was greeted with enthusiasm by Antonio Scarpa, a life-long friend and supporter of Monteggia.

> Pavia, 24 February 1803
> Signor Monteggia:
> Your Istituzioni is excellent; the best book of its kind Italy now has. I will not let this opportunity pass without predicting that you will be my successor in the chair of clinical surgery.
>
> Antonio Scarpa

The second edition of *Istituzioni Chirurgiche* (1813-1816) is Monteggia's major work and lasting monument (Fig. 3). This edition was the last in which he had an active part, but other editions appeared subsequently as late as 1837, 22 years after his death. In this systematic treatise he calls not only upon his own observations but upon that of his predecessors and contemporaries. The volumes are replete with references to the works of van Swietan, Richter and Humbold, to Duvernay, Petit, Desault, Louis, Bichat, Boyer, Larrey, Littre, and Chopart, to the Bell's, Benjamin, Charles and John, to Pott, Brown, Sharp, and of course, John Hunter. Especially interesting are his references to Benjamin Rush, to Smith, and to Physick, whose case of an ununited fracture of the humerus healed by use of a seton is mentioned. In thus selecting and correlating this tremendous mass of foreign literature and in making it available to his Italian contemporaries, Monteggia made his greatest contribution to the development of surgery in Italy.

Widely read by his own countrymen, his work received little attention elsewhere. It has come as a surprise to many therefore to find that one of the earliest descriptions of poliomyelitis came from his pen and is found in the *Istituzioni.*

> "In this connection should be mentioned a certain kind of paralysis limited to one or the other of the lower extremities which I have observed several times in practice but have not yet found in the literature. It occurs in children who are nursing, or not much later; it begins with two or three days of fever, after which one of these extremities is found quite paralysed, immobile, flabby, hanging down, and no movement is made when the sole of the foot is tickled. The fever ceases very soon, but the member remains immobile and regains with time only an imperfect degree of strength. I knew such a person who even when adult remained dragging a weak leg, for it had not become cured by time."

ISTITUZIONI

CHIRURGICHE

DI

G. B. MONTEGGIA

D. Med. Chir., Membro dell' Istituto R. I., Professore di Chirurgia nelle Scuole Speciali, Chirurgo maggiore del grande Spedale di Milano, Socio dell'Accademia Italiana, di quella di Genova, ec.

EDIZIONE SECONDA

RIVEDUTA ED ACCRESCIUTA DALL' AUTORE.

VOL. V.

MILANO

Presso MASPERO E BUOCHER successori dei Galeazzi in Contrada S. Margherita, n. 1108.

1814.

Fig. 3.—Title page of the second edition of *Istituzioni Chirurgiche,* Vol. V, containing the description of Monteggia's fracture.

Only Underwood (1789), Sheldrake (1806), and Joerg (1810) preceded him in the description of poliomyelitis and there is no question that this was an original observation on his part.

Also of interest is his description of the signs and symptoms accompanying a dislocation of the long head of the biceps. Although this lesion had been previously described by anatomists, he was the first to call attention to

the clinical syndrome associated with it. Monteggia also had experience in the treatment of aneurysms by the injection of chemicals designed to produce coagulation of the blood within the aneurysm.

The pressure of work took its toll. In the winter of 1814, Monteggia became ill. In spite of intermittent bouts of fever he continued to practice and to work on his book, portions of which were still in press. On the night of Jan. 5, 1815, he answered the call of duty for the last time, venturing out into the bitter cold to help a woman in labor. Returning home, he became very ill and was confined to bed. Erysipelas appeared about one ear and spread over his face. In spite of treatment he was unable to throw off the infection and died on Jan. 17, 1815.

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Case Reports

CONGENITAL DUODENAL OBSTRUCTION IN THE ADULT

HENRY P. LEIS, JR., M.D., ROBERT K. MATCH, M.D., JAMES M. WINFIELD, M.D., AND WILFRED F. RUGGIERO, M.D., NEW YORK, N. Y.

(From the Department of Surgery, Flower and Fifth Avenue Hospitals and New York Medical College)

OBSTRUCTION of the duodenum due to congenital abnormalities is not too uncommon in the newborn or during infancy and childhood. In the adult, however, most types of congenital duodenal obstruction are rare.

In obstruction of the duodenum there is a mechanical interference with the passage of duodenal contents in counter distinction to chronic dilatation of the duodenum or megaduodenum congenitum which is probably due to some form of neuromuscular derangement resulting in duodenal retention (stasis).[26]

Causes of duodenal obstruction in adults on a congenital basis can be divided into two types depending on whether the obstruction is due to some form of faulty midgut rotation or not.

Enterogenous cysts (duplications of the duodenum),[4, 12, 14, 16a, 21b] congenital stenosis,[7, 16, 21, 28] annular pancreas,[13a, 32, 33] and duodenal diverticula,[3, 8, 9, 17, 30, 33a] are all types of congenital anomalies, not associated with some abnormality in midgut rotation, that have caused duodenal obstruction in the adult.

Faulty midgut rotation may result in a variety of conditions which can produce congenital duodenal obstruction in adult patients. These are volvulus,[13, 21a, 24, 25] mesenteric duodenal obstruction (Wilkie's syndrome),[15, 19, 29] paraduodenal hernias,[2, 6, 22, 31, 33b, 34] and peritoneal folds, congenital adhesive bands, and abnormally positioned proximal colons.[1, 5, 11, 13, 18, 20, 21a, 23]

Excellent descriptions of normal and abnormal intestinal rotation are given by Dott,[10] Marx,[24] Ladd and Gross,[21a] Gardner,[13] Shackelford and Dugan,[33b] and Miller.[27] In order to understand the above types of anomalies that may cause duodenal obstruction in the adult on the basis of faulty midgut rotation, one should be familiar with the normal pattern of intestinal rotation and variations from it.

Except in cases of duodenal obstruction due to an annular pancreas or duodenal diverticulum, the obstructive symptoms in these congenital cases usually appear at an early age. Nearly all cases requiring surgery, except in those cases of congenital obstruction due to mesenteric obstruction, annular

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pancreas, or duodenal diverticulum, are operated upon before the early teens, and the vast majority of such operations are performed within the first few years of life. Furthermore, practically all of the cases operated upon in the older age groups have symptoms dating back to early childhood with recurrent attacks of abdominal pain and vomiting.

Physical findings are usually of little help in diagnosis, and roentgenograms offer the only definitive diagnostic aid. Differential diagnosis, however, as to the type of congenital duodenal obstruction, is often impossible preoperatively.

The type of congenital duodenal obstruction found in the case to be presented falls into the classification of obstruction due to faulty midgut rotation. It has been described in detail by Ladd and Gross,[21a] and Ladd's operation is the best procedure for relief of the obstruction.

It is not too uncommon a type of obstruction in the newborn or during infancy and childhood, but as far as we could determine in reviewing the literature, no case of total obstruction of the duodenum on a congenital malrotation basis due to a peritoneal fold extending from an incompletely rotated cecum found just below the distal half of the stomach, across the duodenum to the right posterolateral part of the abdominal wall, has been reported in a patient as old as thirty years with only a short history of previous gastrointestinal complaints. Because of this, we are reporting the following case of total congenital extrinsic duodenal obstruction in an adult due to a peritoneal fold with malrotation of the midgut, rotation having stopped after completion of the second stage.

CASE REPORT

E. M., a 30-year-old Puerto Rican man, was admitted to Flower and Fifth Avenue Hospitals on Jan. 18, 1955. He was complaining of epigastric pain and fullness, followed by nausea and vomiting, after the ingestion of food or fluids of any type, of five days' duration. Vomiting relieved the discomfort but as soon as he ate it returned. The vomitus at times contained bile and the patient stated that he was getting progressively weaker. He further stated that he had been completely well and had never had any gastrointestinal complaints until four years before, when he had had a similar, less severe episode for which he was hospitalized elsewhere. A gastrointestinal series was done at that time and was reported as showing distortion of the rugal folds in the antrum of the stomach, spasticity of the duodenal bulb, and distention of the second part of the duodenum with moderate spasticity of the first part. A diagnosis of gastroduodenitis was made and he was treated conservatively. One year prior to the present admission he had another attack of pain, nausea, and vomiting which lasted four days and resolved without treatment. Following this he was well again up until his present admission.

Physical examination revealed a well-developed Puerto Rican man who did not appear acutely ill. Blood pressure was 90/60. Pulse was 130. Respirations were 16. Temperature was 100° F. Significant findings were confined entirely to the abdomen. There was no evidence of distention; peristalsis was normal. There was moderate tenderness deep in the epigastrium. No masses or organs were palpable.

Laboratory studies showed a hemoglobin of 18 grams; r.b.c. 5 million; w.b.c. 7,000 with 65 per cent neutrophiles, 23 per cent lymphocytes, 2 per cent eosinophiles and 10 per cent monocytes. Sedimentation rate was 20 mm. in one hour. Hematocrit 55 per cent. Urinalysis and serum amylase were normal. Blood chemistry showed sodium 130 meq., chlorides 83.9 meq., potassium 2.7 meq., CO_2 combining power 29.5 meq.

A Levin tube was passed and gastric suction instituted. The patient was given intravenous feedings of balanced electrolyte solutions to correct the sodium and potassium deficit. On Jan. 20, 1955, a gastrointestinal series was performed which revealed complete obstruction at the third portion of the duodenum with distention of the stomach and proximal duodenum (Figs. 1 and 2).

On January 21, the patient was subjected to laparotomy. The abdomen was opened through an upper abdominal transverse incision, both rectus muscles being divided. Upon entering the abdominal cavity, the cecum and appendix were found in the right upper quadrant and the ascending and transverse colon presented themselves in the operative field. Exploration revealed a malrotation of the midgut, rotation having come to a standstill after completion of the second stage, the third stage having failed to follow. The

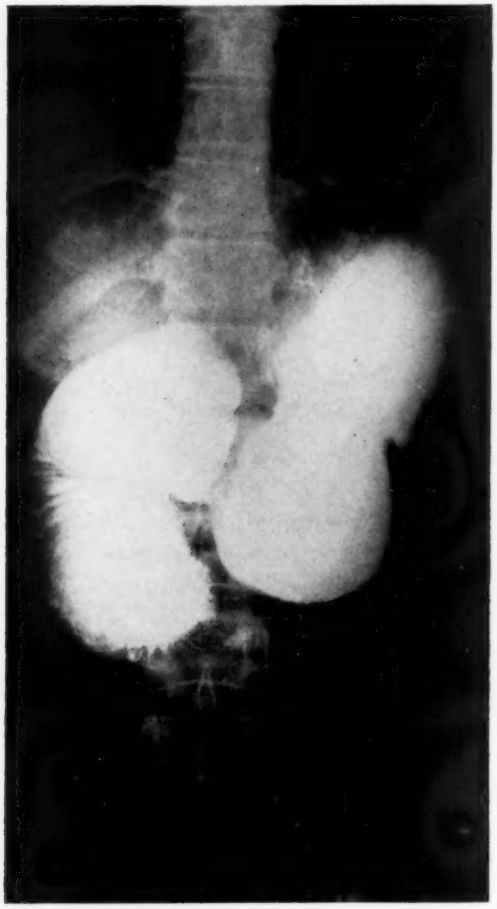

Fig. 1.

Fig. 2.

cecum had not descended to the right lower quadrant of the abdomen and there was incomplete fixation of the mesentery of the small bowel to the posterior parietal wall of the abdomen but there was no evidence of volvulus. The first and second portions of the duodenum were found to be markedly dilated and there was a complete obstruction of the duodenum in its third portion. This obstruction was caused by a thick peritoneal fold measuring about 7.5 cm. in width and 1 cm. in thickness which extended from the cecum and ascending colon to the right posterolateral part of the abdominal wall. This peritoneal fold was incised just to the right of the cecum which permitted clearing of the anterior

surface of the duodenum until it was exposed in its entirety. By this procedure the cecum was transferred to the left. No attempt was made to restore the anatomical position, but the appendix was removed because it had been traumatized during the procedure. Following this procedure the obstruction of the duodenum was completely relieved. A Cantor tube was threaded through the duodenum past the ligament of Treitz into the jejunum. The abdomen was then closed in layers.

The patient made a completely uneventful recovery. The Cantor tube was removed on the fifth postoperative day and the patient was discharged on the twelfth postoperative day. He has remained completely asymptomatic since his discharge.

SUMMARY

Causes of duodenal obstruction in the adult on a congenital basis are listed with references, and a case of total obstruction of the third portion of the duodenum in a thirty-year-old man of a congenital extrinsic type due to a peritoneal fold with malrotation of the midgut, rotation having stopped after completion of the second stage, is reported in detail.

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LEIOMYOMA OF THYROID GLAND

Report of Case

James W. Hendrick, M.D., Tuscaloosa, Ala.

TUMORS of the thyroid gland other than those of epithelial origin are infrequently encountered. The most frequent thyroid tumors include fetal adenoma, carcinoma, mixed tumors, teratoma, sarcoma, and malignant lymphomas, i.e., lymphosarcoma and Hodgkin's disease. There has been no tumor of smooth muscle origin involving the thyroid reported to date. For that reason it seems worth while to report a leiomyoma involving the right lobe of the thyroid gland observed in a three-year-old child.

CASE REPORT

The patient was first seen in 1953. The child's parents stated that when the child was about one year of age they observed a tumor in the right side of the neck which had gradually increased in size. The child had been in good health, with no serious illnesses or operations. The child came from a section of Mexico where goiter is not endemic. There was no history of goiter in any other members of the immediate family. The mother, father and five other children were in good health.

Examination revealed a well-developed, well-nourished child of about three years of age. A tumor the size of a golf ball was present in the right lobe of the thyroid gland. The tumor was firm, freely movable and was attached to the deeper structures in the region of the right lobe of the thyroid gland. There were enlarged lymph nodes in each jugular chain about a half cm. to one cm. in diameter. The isthmus and left lobe of the thyroid were normal. The erythrocyte, leukocyte counts and urine examination were normal. Roentgenographic examination of the chest was normal. A provisional diagnosis of discrete fetal adenoma of the right lobe of the thyroid was made.

The patient was admitted to the Baptist Memorial Hospital on June 1, 1953, and prepared for hemithyroidectomy. At operation there was a tumor mass involving the entire right lobe of the thyroid which was removed. After its removal only the posterior capsule of the gland remained. The isthmus and left lobe of the thyroid were normal. There was no attachment of the tumor mass to the prethyroid muscles or to the cervical fascia.

Pathological Examination.—Specimen consisted of an encapsulated, firm, rubbery, pinkish gray mass of tissue weighing 15 grams and measuring 3.5 by 2.25 by 3 cm. On section, the cut surface was bulging and showed glistening, whorled, gray and pinkish tissue. The capsule retracted away from the tissue.

Microscopic examination revealed the tumor to consist of many whorls and interlacing bundles of cells of smooth muscle associated with fibrous connective tissue cells. In areas where the tumor cells were cut longitudinally the nuclei were elongated with round or blunt ends. These cells on cross section showed slight vacuolation of the cytoplasm around the nucleus and in some places there was palisading of the nuclei around the islands of hyalinized collagen; other areas showed calcium deposits. The histologic picture of the tumor simulated that of leiomyomata observed in the uterus. No thyroid tissue was associated or connected with the tumor in any of the twelve sections.

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The trichrome preparation showed vast areas of dense hyalinized fibrous connective tissue that stained a deep blue. In other areas the muscle cells stained red.

The patient made an uneventful recovery and was dismissed from the hospital on the fourth postoperative day. The patient has been followed in the cancer clinic in Coahuila,

Fig. 1.—Gross specimen, leiomyoma of the right lobe of the thyroid gland.

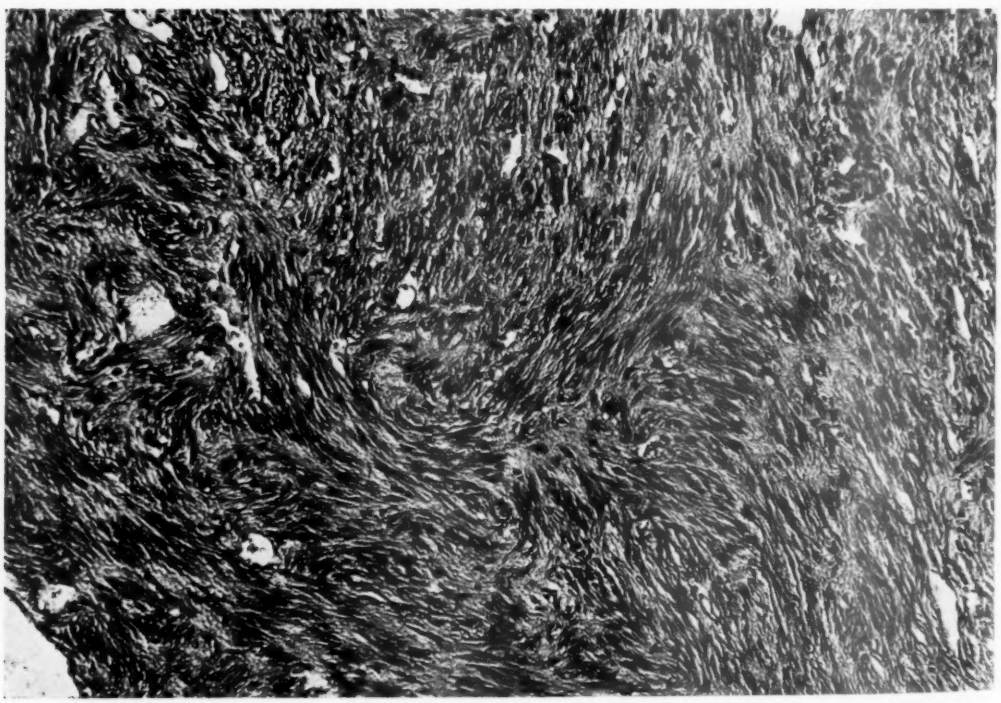

Fig. 2.—Photomicrograph of tumor showing interlacing, smooth muscle fibers with round, elongated nuclei. There are some areas of dense hyalinized fibrous connective tissue.

Mexico, at intervals of three to four months. She has developed normally with no evidence of recurrence of the tumor.

In a series of over 1,300 consecutive thyroidectomies, this is the first tumor involving the thyroid gland that contained smooth muscle. In further questioning the parents it was learned that the child's delivery was normal; no instrumentation was used. When the nature of the tumor was shown by frozen section at the operating table, diligent examination was made to determine its origin; care was exercised to be certain that there was no connection between the tumor and the prethyroid muscles. Only a very thin capsule remained posteriorly after its removal. If the tumor had replaced the normal thyroid lobe some thyroid tissue should have been attached to the tumor. Radioisotope studies made one year later did not reveal any thyroid tissue in the region of the right lobe.

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CARCINOMA OF THE BREAST SEVENTEEN YEARS AFTER MAMMOGRAPHY WITH THOROTRAST

HENRY BRODY, M.D., AND MILTON CULLEN, M.D., PHILADELPHIA, PA.

(From the Departments of Pathology and Surgery, Albert Einstein Medical Center, Northern Division)

NEOPLASTIC change following exposure to ionizing radiation has been well documented.[9] Despite this, radioactive substances in significant dosage have been introduced into patients for diagnostic purposes. Thorotrast, a colloidal solution of thorium dioxide, of known radioactivity, has been utilized for visualization of the reticuloendothelial system, and has been injected to outline duct systems and tissue spaces.[2, 5, 15, 31, 33] In 1936, its use was enthusiastically advocated for mammography by Hicken.[12] Its dangers were pointed out shortly thereafter in an editorial in the Journal of the American Medical Association.[7] Nonetheless, its use continued. There have been reports of a small number of cases in which malignant tumors have developed at sites of injection or deposition.

In 1947, MacMahon, Murphy, and Bates[18] reported the first case in which a malignant tumor followed the diagnostic use of Thorotrast. Twelve years after the demonstration of a hepatic gumma by intravenous injection of Thorotrast, the patient died of hemorrhage from an "endothelial-cell sarcoma" of the liver. Thorotrast was found in the liver as well as in other organs.

In 1949, Zollinger[35] reported a case in which a sarcoma developed in a kidney into which Thorotrast had been injected sixteen years before.

In 1950, Rudolphi[29] described a squamous-cell carcinoma developing in the lower eyelid many years after instillation of Thorotrast into the tear sac.

The same year Abrahamson and associates[1] described a case of alveolar carcinoma of the lung sixteen years after the intravenous injection of Thorotrast. It should be pointed out that radioactive material was demonstrable only in the liver and the spleen, and not in the lungs.

The following year Horta,[13] and, in 1953, Lüdin,[16] presented cases of liver sarcoma, occurring three years and sixteen years, respectively, after Thorotrast injection. Both cases were similar, histologically, to that described earlier by MacMahon and associates.[18]

In 1952, Vögtlin and Minder[32] described a squamous-cell carcinoma of the lung which developed subsequent to intrabronchial instillation of Thorotrast for demonstration of bronchiectasis. The authors point out the uncertainties of causal relation in this case, particularly in view of the known development of squamous metaplasia and neoplasia in bronchiectasis.

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Plenge and Krückemeyer,[24] in 1954, reported the development of a fibrosarcoma attached to the wall of the carotid artery, developing five years after intra-arterial injection of Thorotrast at that site for the purpose of cerebral angiography. Accumulations of Thorotrast were demonstrated in the tumor.

Experimental tumors have been produced in a variety of animals at different sites of storage of Thorotrast. Roussy and associates[28] produced intraperitoneal and subcutaneous sarcomas in mice. In 1939, Foulds[8] injected Thorotrast into the mammary ducts of guinea pigs, producing tumors. Tumors in a variety of animals have been produced with Thorotrast by Prussia,[26] Miyamoto,[21] Onufrio,[23] Selbie,[30] Andervont and Shimkin,[3] and Zeitlhofer and Speiser,[34] as well as many others.

Fig. 1.—Roentgenogram showing the densities which suggested Thorotrast.

There are many reports[4, 6, 13, 14, 17, 19, 25, 27, 32] of foreign body granulomas in many different tissues following diagnostic introduction of Thorotrast. These have been reported as "Thorotrast tumor," "Thorotrast granuloma," and "Thorotrastoma." A granulomatous tumor following intraductal mammary injection of Thorotrast was reported by Mora.[20] He pointed out the dangers of such injection. We have found no report of a malignant tumor following the use of Thorotrast for mammography. Recently, such a case came to our attention. In spite of the fact that it is not possible to prove a

necessary connection between Thorotrast injected in 1937 and a carcinoma developing in 1954 at the site of the Thorotrast injection, it is felt important to put the case on record.

CASE REPORT

A 43-year-old white woman was admitted to the Northern Division of the Albert Einstein Medical Center because of a mass in the right breast, first noticed about six months before as a nontender firmness just medial to the nipple. Four months before admission, the patient noticed that the nipple was being pulled medially. Menstrual history was normal. Her last pregnancy had been 21 years before.

Physical examination, except for the breast, was negative. In the right breast, a firm, poorly-defined mass, approximately 2 cm. in diameter was found just below and medial to the nipple. The overlying skin was free. The nipple deviated toward the mass. Two old, well-healed surgical scars were present in the inferior outer quadrant of the breast. No nodes were felt in the axilla. The clinical impression was a carcinoma of breast.

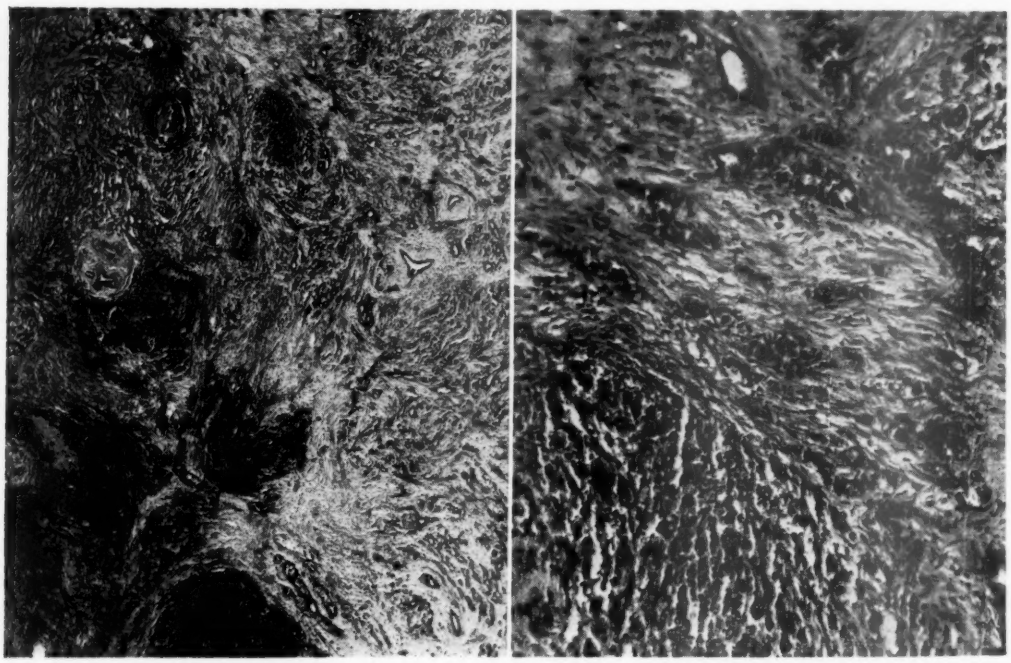

Fig. 2. Fig. 3.

Fig. 2.—Photomicrograph showing partly scirrhous carcinoma and the Thorotrast. The dense masses in the left lower portion represent the Thorotrast.

Fig. 3.—Higher power, showing intermixture of carcinoma and Thorotrast.

X-ray examination of the breast (done as part of an investigative project)[11] revealed an unusual picture (Fig. 1) with a region of marked radiation density in the region of the palpable mass. It was suggested that this might be due to deposition of Thorotrast.

Investigation then elicited the information that, in 1937, the patient had been treated in another hospital for a painful lump in her right breast, present after a "caked-breast," which followed a pregnancy four years previously. Examination in 1937 showed somewhat atrophic breasts, with a semifluctuant, very slightly tender mass approximately 2 by 2 by 1 cm. just below the right nipple. It was freely movable and not adherent to the skin.

Before operation, Thorotrast was injected to outline the mass. A mass measuring 3 by 2 by 1.5 cm. was removed. Its substance was firm, nodular, and grated on cutting, and consisted of a number of round, bulging, well-encapsulated tumors. Histologically, it was a fibroadenoma. Thorotrast was found both within and outside of ducts.

The patient was again seen at the same hospital, in 1941, because of a palpable mass which grew larger at the time of the menstrual period. A small movable tumor was palpated lateral to the nipple of the right breast, and a second, pea-sized, toward the axilla. The latter, not palpable after admission to the hospital, was not removed. The former proved to be a fibroadenoma. No Thorotrast was recognized in the section.

The day following admission in 1954 the patient was taken to the operating room for biopsy. It was then learned that blood was not available for transfusion (the patient's hemoglobin was 9.5 gm.). It was felt that the lesion might be a Thorotrast granuloma, and it was decided to proceed with biopsy, and to postpone radical surgery should it prove necessary. Biopsy and frozen section revealed a carcinoma associated with accumulation of a particulate pigment, having the morphology of Thorotrast.

Fig. 4.—Axillary lymph node, containing Thorotrast and carcinoma.

The surgical biopsy was an irregularly shaped mass 3 by 2 by 2 cm. The cut surface showed an ill-defined tumor with yellow stippling. The paraffin section showed a tumor measuring 2 by 1 cm. having the usual morphology of duct carcinoma of breast (Figs. 2 and 3). In places, it showed some fibrosis. At the center of the tumor an accumulation of brown pigment granules were found entirely within macrophages. Some calcific deposits were intermixed with the Thorotrast. Nests of tumor cells were present in the area of pigment accumulation. Although the pigment was centrally located, it was not circumscribed, and, at the edges, tumor and pigment were intermixed. Bundles of fine fibrous tissue traversed both pigment accumulations and tumor.

Following this, an x-ray survey of the body was carried out. No evidence of Thorotrast accumulation was found in the liver or spleen, nor in the long bones. A small shadow of increased density in the right axillary area was interpreted as possibly representing Thorotrast deposition, but an alternate explanation of a calcified axillary node was also offered.

Three days after the biopsy, a right radical mastectomy of the Haagenson type, with skin grafting, was done. No residual carcinoma was found in the breast. Metastatic carcinoma was found in only one of twelve axillary lymph nodes (Fig. 4). This node also contained Thorotrast in considerable quantity. Minute amounts of Thorotrast were also found in several of the other nodes.

Nineteen months following mastectomy there was no evidence of recurrence or metastasis.

It is suggested that the occurrence of the metastatic carcinoma and the largest quantity of Thorotrast in the same lymph node is not coincidental. It seems probable that the Thorotrast first, and many years later the tumor, were arrested at the first node in the lymphatic drainage. It is even possible that blockade by the Thorotrast might have served to have hindered further extension of the tumor.

The demonstration that the pigmentary substance was Thorotrast was carried out by autoradiographic and electroscopic methods by the Department of Radiology, and will be separately reported upon by them.

DISCUSSION

We do not hold that this case demonstrates certainly the production of mammary cancer by the introduction of Thorotrast seventeen years before. It is of considerable interest that of the cases of malignant neoplasm following intimate exposure to Thorotrast, most have occurred more than five years after the injection. Prezyna, Ayres, and Mulry[25] have quoted Orr and associates to the effect that the radioactivity of thorium dioxide decreases over a period of five years, but then increases in the next fifteen years due to formation of other members of the radioactive family which are strong alpha emitters. Nosik[22] stated that 25 c.c. of Thorotrast is equivalent to between 0.5 and 1.0 meg. of radium as an alpha emitter; that its emission of beta rays is too feeble to be of physiological significance; and that it emits gamma rays equivalent to 0.3 meg. of radium and is, therefore, too feeble to be of physiologic significance.

Carcinoma is, of course, the common malignant tumor occurring in the breast. Most of the experimental tumors produced by Thorotrast have been sarcomas, though Foulds[8] has produced a transplantable carcinoma of the breast in a guinea pig by injection of Thorotrast into its duct system. Spontaneous mammary carcinomas in guinea pigs are very rare. It is of interest to quote Foulds: "The carcinoma developed at the exact site of the Thorotrast injection, contained Thorotrast, and appeared in the same order of time as the other Thorotrast tumors; it was, beyond reasonable doubt, the direct result of the action of Thorotrast." The aptness of this to the present case is striking. Nonetheless, as suggested in a personal communication from Furth,[19] had a sarcoma been found, causal relation between Thorotrast and tumor would be on firmer ground.

SUMMARY

A case is reported of mammary carcinoma developing in a 43-year-old woman seventeen years following the use of Thorotrast for mammography. Carcinoma and Thorotrast were both demonstrated in the breast, and in one axillary lymph node. Preliminary x-ray studies had demonstrated opacities in the breast and axilla, interpreted as possibly Thorotrast.

Although absolute proof of causal relationship is not present, it is felt that the use of Thorotrast carries with it too much danger to justify its use as a routine diagnostic procedure.

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PRIMARY MALIGNANT MELANOMA OF THE ESOPHAGUS

JOHN L. KEELEY, M.D., JAMES A. ROONEY, M.D., ANTHONY C. GUZAUSKAS, M.D., AND G. BRYNJOLFSSON, CHICAGO, ILL.

(From the Departments of Surgery and Pathology, Stritch School of Medicine of Loyola University and Mercy Hospital)

THE recent report of Pomeranz and Garlock[16] emphasizes the rarity of primary malignant melanoma of the esophagus. Their patient is the fifth in which the diagnosis is based on currently acceptable criteria. One other reported case very probably qualifies as primary in the esophagus. We wish to report an additional instance of this rare tumor. We believe it to be a primary malignant melanoma of the esophagus which appears to be the seventh such case in the literature.

CASE REPORT

A white woman, aged 62, entered the hospital on Dec. 4, 1950, with chief complaints of interscapular and substernal discomfort of one year's duration, and dysphagia which had prompted a self-imposed liquid diet during the previous six weeks. She had lost 20 pounds in the past four months. X-ray studies made prior to admission disclosed a filling defect in the middle third of the esophagus (Fig. 1).

Physical examination showed a patient in good general physical condition with normal respiratory and cardiac function. Laboratory studies revealed a red blood count of 3,800,000 with 13 Gm. of hemoglobin, nonprotein nitrogen 32 mg., plasma protein 5.3 Gm. with an albumin-globulin ratio of 2:1. Barium esophagram again showed a filling defect of the esophagus from the level of the fifth to the eighth dorsal vertebral bodies. Sufficient barium reached the stomach to demonstrate its normal outline. There was no abnormality of the lung fields or of the thoracic and vertebral body structures. The electrocardiogram showed evidence of "heart strain."

Esophagoscopy revealed an irregular and friable tumor mass 30 cm. from the incisors. It bled readily as a biopsy specimen was obtained. A microscopic diagnosis of sarcoma of undetermined origin, possibly reticulum cell, was made. Inflammatory and degenerative changes made interpretation difficult. The anemia and hypoproteinemia were corrected with suitable therapy and antibiotics were administered. Operation was performed on Dec. 13, 1950.

Under general anesthesia with endotracheal technique and with provision for access to the left side of the thorax and left supraclavicular region the chest was opened through the bed of the seventh rib. The tumor, 10 cm. long, was found involving the esophagus with its upper limits just below the lower border of the aortic arch. The esophagus was mobilized to determine resectability. The diaphragm was incised and no spread of the tumor was found in the upper abdomen. Resection of the esophagus with cervical esophagogastrostomy was performed, the stomach being brought up behind the arch of the aorta and the esophagogastric anastomosis being performed with the cardia of the stomach and the upper end of the esophagus delivered through a supraclavicular incision. The thorax was drained and the wounds were closed. The patient withstood the operation well, made a satisfactory recovery, and was dismissed from the hospital on the seventeenth day.

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The surgical specimen (Fig. 2) consisted of a 16 cm. segment of esophagus. On opening the esophagus an oval shaped tumor mass was noted measuring 8 by 6 cm. The long axis of the tumor was parallel to the long axis of the esophagus. The mucosal aspect of the tumor was irregularly nodular and showed areas of ulceration covered by exudate.

Fig. 1.—Barium esophagram demonstrating the filling defect.

The tumor was friable, gray-tan with brown and black areas. On sectioning, the tumor appeared to extend into the muscular layer in areas. No tumor, however, was visible on the outer aspect of the esophageal segment. Attached were a few small, black, soft lymph nodes. The mucosa around the tumor was purplish-tan and freely movable.

Microscopic examination (Fig. 3) revealed a tumor replacing the mucosa and submucosa and extending in areas into the muscular layer. The tumor cells were for the most part rather large, polyhedral, with fairly distinct cell outline and relatively large, moderately anaplastic nuclei, many of which contained nucleoli. Mitoses were quite frequent. In areas, the cells were arranged in large, compact masses. Elsewhere they were arranged in smaller groups and sheets, often with columnar cells at the periphery. There was a moderate amount of connective tissue stroma and considerable focal infiltration by lymphocytes and plasma cells. Abundant melanin pigment was noted in areas both in the tumor cells and macrophages. Tumor cell masses were seen inside small blood vessels and lymphatics. The tumor surface was necrotic in areas and ulcerated. Where the epithelium was still preserved, some intraepithelial groups of tumor cells were noted with loosening of the basal epithelial cells. In areas, the loosened basal cells seemed to be continuous with the cells of the underlying tumor. The lymph nodes showed anthracosis, but no tumor metastases were found.

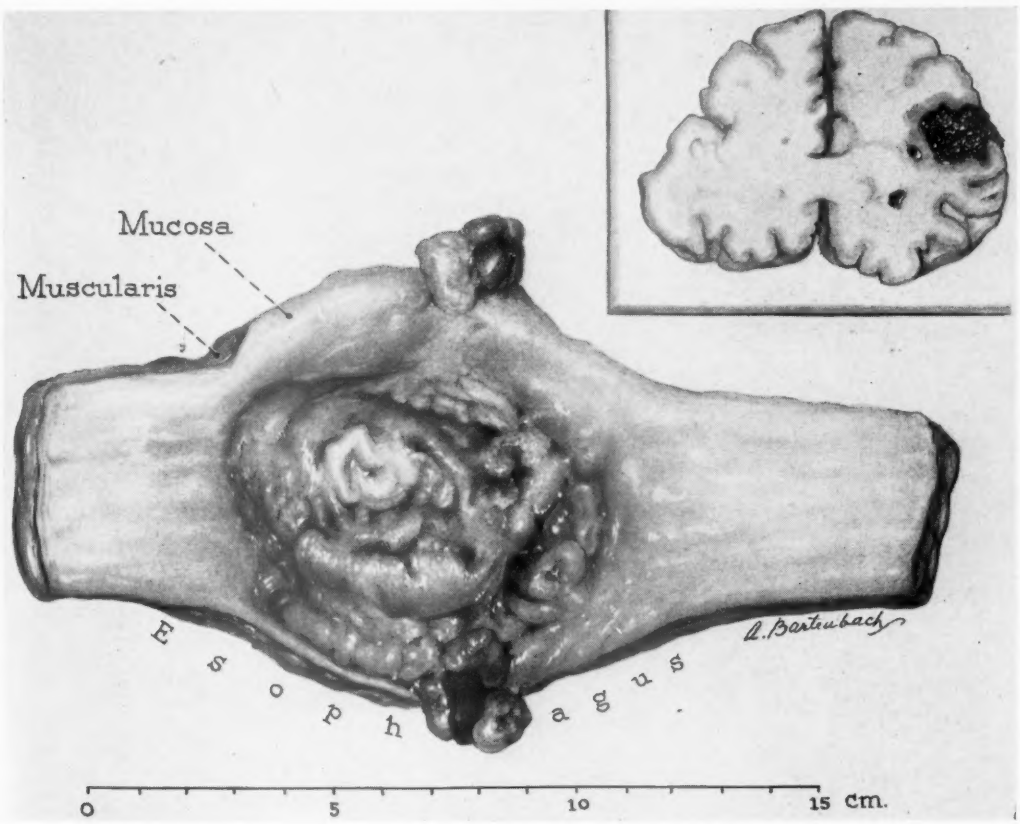
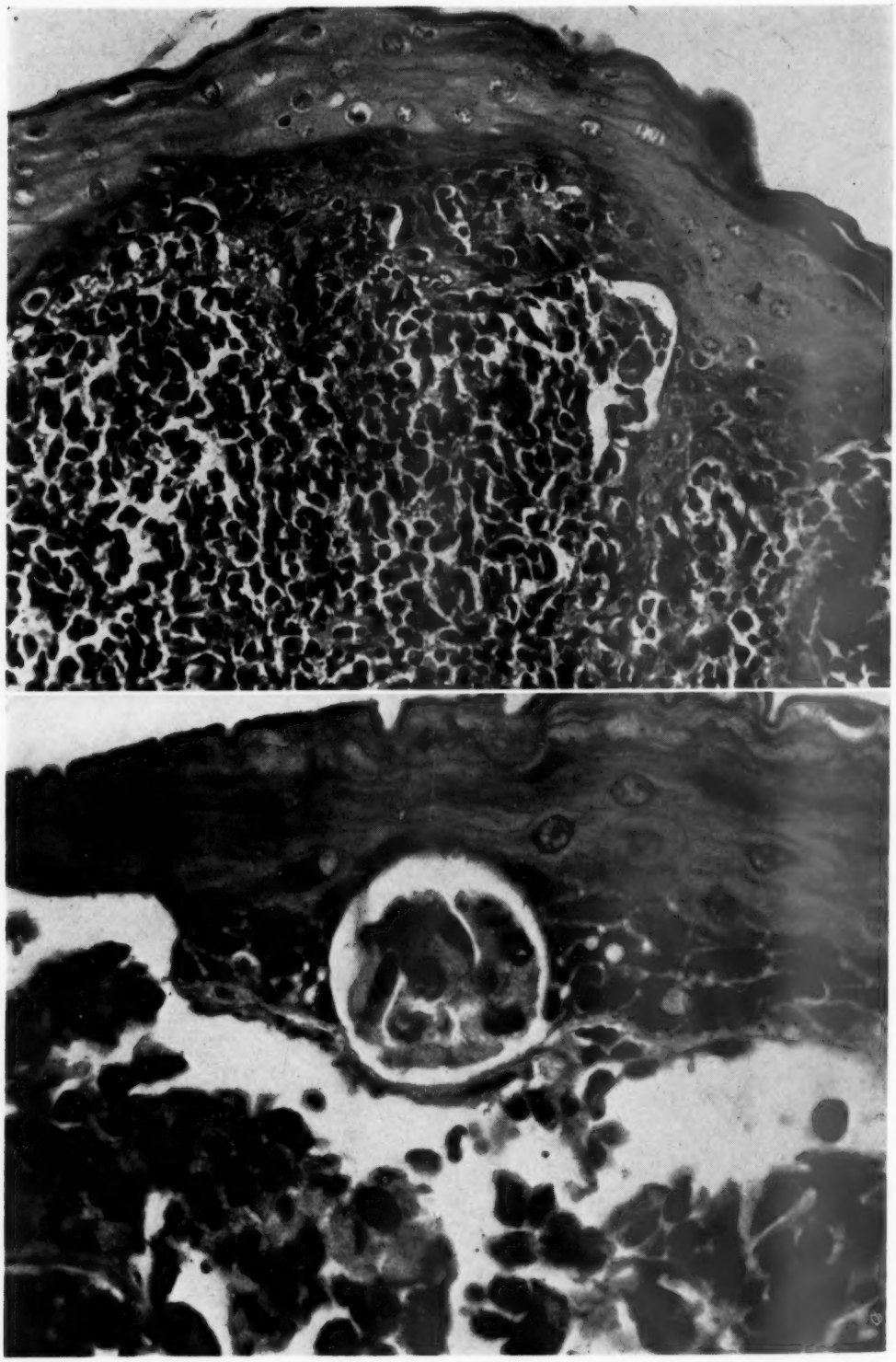


Fig. 2.—Drawing made from photograph of surgical specimen. Insert shows cerebral metastatic lesion in right frontal lobe.

Seven months later two small supraclavicular nodes were palpated in the left side of the neck and one month later the patient was hospitalized in a terminal state and died within a few hours. Significant findings at autopsy were widespread metastases including mediastinal and supraclavicular nodes and multiple metastatic lesions of the brain (Fig. 2). There was no evidence of primary tumors of the skin, gastrointestinal, or urinary tracts. The microscopic section showed melanin containing cells identical with those found in the resected specimen. The previous conclusion that this was a primary malignant melanoma of the esophagus appeared to be substantiated.

A.



B.

Fig. 3.—Sections from the mucosa of the esophagus showing junctional changes: *A*, shows loss of cohesion and disarrangement of the basal cells of the stratified squamous mucosa. The basal cells merge with the underlying tumor. *B*, shows rounded nest of intraepithelial tumor cells.

DISCUSSION

The literature at present contains references to 14 instances of malignant melanomas thought to represent primary esophageal tumors. They are briefly presented in chronologic order as follows:

CASE 1 (Baur,[3] 1904-1906).—A 69-year-old man had esophageal obstruction at the level of the bifurcation of the trachea. Autopsy disclosed a tumor on the anterior wall of the esophagus with a tracheo-esophageal fistula. The tumor cells, which were round, spindle-shaped, or oval, had invaded the submucosa and a diagnosis of melanosarcoma of the esophagus was made. It was considered primary since no evidence of similar tumor was found elsewhere in the body.

CASE 2 (Joliat,[13] 1907).—At autopsy a 62-year-old man was found to have an irregular polypoid melanotic tumor in the lower part of the esophagus. A second smaller but similar tumor was found in the mid-esophagus. Black tumors of various sizes were found in the enlarged liver. This patient was considered to have a primary malignant melanoma of the esophagus with metastatic involvement of the liver.

CASE 3 (Hofmann,[11] 1920).—A 61-year-old man expired following a period of esophageal obstruction. A tumor composed of spindle-shaped cells containing pigment which gave a negative reaction to iron stains was found in the lower portion of the esophagus. Since no evidence of any other tumor was found, this was considered to be a primary melanosarcoma of the esophagus.

CASE 4 (Moersch and Broders,[14] 1927).—A 59-year-old woman presented an ulcerated black tumor mass on esophagoscopy and the biopsy specimen was interpreted as a melanoepithelioma. No surgery was performed. The patient's condition was deteriorating rapidly five months later.

CASE 5 (Voss,[18] 1928).—A 59-year-old man with esophageal obstruction and paralysis of the left arm presumably due to a "stroke" was found at autopsy to have a pedunculated esophageal tumor with walnut size masses in the periesophageal tissues and metastases to the brain, lungs, jejunum, and sigmoid. These findings were interpreted as representing primary melanosarcoma of the esophagus with metastases as indicated. A cerebral metastasis in the right anterior central gyrus was thought to be the cause of the paralysis of the left arm instead of apoplexy.

CASE 6 (Jaleski and Waldo,[12] 1935).—A 69-year-old man had an elongated tumor in the lower end of the esophagus and several smaller tumor masses in the regional periesophageal tissues and nodes. Metastatic lesions of the lungs, liver, pancreas, and spine were found. This was interpreted as a primary melanosarcoma of the esophagus with metastases as indicated.

CASE 7 (Burnett and St. John,[6] 1951).—A 55-year-old woman underwent esophageal resection for a tumor of the mid-esophagus invading all layers of the esophagus and the adjacent lymph nodes. A diagnosis of primary melanosarcoma of the esophagus was made. The patient survived ten months and died of what appeared to be a cerebral vascular accident. Permission for autopsy was denied.

CASE 8 (Chalmagne,[7] 1951).—A 68-year-old woman had a dark, papillomatous growth 29 cm. from the incisors and biopsy disclosed a melanosarcoma. The tumor was considered primary, as there was no evidence of other tumors. Esophagram at a later date revealed extension of the tumor, and metastases to the supraclavicular nodes were present.

CASE 9 (Fowler and Sutherland,[9] 1952).—A 60-year-old woman had an obstructing, dark, fibrous mass 24 cm. from the incisors. Microscopic interpretation of a biopsy specimen was malignant melanoma primary in the esophagus. An esophageal resection was performed. The patient died on the third postoperative day. No evidence of residual tumor was found.

CASE 10 (Garfinkle and Cahan,[10] 1952).—A 55-year-old woman was found to have a malignant melanoma of the upper esophagus by biopsy. There were multiple pigmented lesions about the head and trunk resembling keratotic papillomas. Resection of the esophagus was done. The patient died on the eighteenth postoperative day. The peritracheal lymph nodes show metastatic tumor similar to the tumor of the esophagus which was diagnosed as a primary malignant melanoma. No gross or microscopic evidence of residual tumor in the operative area was found.

CASE 11 (Bullock, Thompson and Gregory,[5] 1953).—A 71-year-old male underwent an esophagectomy for a tumor on which a biopsy report of "cancer unable to further define" had been made. The microscopic examination of the resected specimen disclosed malignant melanoma with junctional changes. The tumor was therefore regarded as primary in the esophagus.

CASE 12 (Boyd,[4] 1954).—A 63-year-old man underwent biopsy of a polypoid lesion of the lower part of the esophagus. The specimen showed only esophageal mucosa with acute inflammatory reaction. Because of the obvious tumor, resection and supra-aortic esophagogastrostomy were done. Microscopic diagnosis was "malignant melanoma, primary in the esophagus." No evidence of tumor elsewhere was found either before or after operation. He made an uneventful recovery and was well eight weeks after operation.

CASE 13 (Robertson,[17] 1954).—A 58-year-old male had black stools for a few months. Study of the gastrointestinal tract disclosed lesions in the rectum, hepatic flexure, and a possible abnormality of the gastroesophageal junction. A polypoid adenoma with foci of adenocarcinoma was removed from the hepatic flexure and a rectal resection and pull through operation was done for villous adenoma with foci of adenocarcinoma in situ. No abnormality was palpated in the upper half of stomach. Gastrointestinal bleeding continued and a large polypoid lesion at the gastroesophageal junction was removed. It was diagnosed as undifferentiated carcinoma. Autopsy one year later disclosed metastases to inguinal lymph nodes, lungs, liver, pancreas, and peritoneum which were diagnosed malignant melanoma on frozen section. Immediate thorough search failed to disclose a primary site other than the esophagus. The original sections of tumor were restudied but no junctional changes were demonstrable. In view of the extremely rare instances when tumors of any kind metastasize to the esophagus it was reasoned that all evidence pointed to the diagnosis of primary malignant melanoma of the esophagus and that junctional changes could have been obliterated by growth in this large tumor. The esophageal specimen was discarded before the diagnosis of undifferentiated carcinoma was corrected to malignant melanoma so that additional sections were not available for study.

CASE 14 (Pomeranz and Garlock,[16] 1955).—A 48-year-old woman had a polypoid tumor filling the lumen of the esophagus 29 cm. from the incisors. Biopsy proved it to be melanocarcinoma. Esophageal resection with supra-aortic esophagogastrostomy was performed. Patient was dismissed on the twelfth postoperative day and was well when last seen one year after operation. After detailed study of the tumor, final diagnosis of primary polypoid malignant melanoma, primary in the esophagus, was made.

HISTOGENESIS OF MALIGNANT MELANOMA

There is still a difference of opinion as to the histogenesis of malignant melanomas, whether they are derived from epithelium or neuroepithelium or are of mesoblastic origin. Their controversial source and the varied histological appearance of the melanomas account for the confusing terminology of melanosarcoma, melanocarcinoma, and melanotic epithelioma. Malignant melanomas show marked variation in their histological structures. Some are composed of spindle-shaped cells giving the appearance of sarcoma, while

others may simulate squamous or basal-cell carcinomas or even adenocarcinomas. The same tumor may vary histologically from one area to another as was the case in the tumor here presented. In view of this structural variation of melanomas and the conflicting opinions regarding their histogenesis, the noncommittal designtion of malignant melanoma seems to be preferable.

Dawson,[8] Nicholson,[15] and, more recently, Allen[1, 2] have presented strong evidence in favor of the epithelial origin of cutaneous melanomas and melanomas of mucous membranes. Allen maintains that in primary malignant melanomas of the skin and mucous membranes there is always present an intraepithelial proliferation of tumor cells (with rare exceptions like malignant blue nevi) unless the epithelium has been destroyed by ulceration. In only five of the previously reported cases[4, 5, 9, 10, 16] of malignant melanoma of the esophagus are such intraepithelial changes described. Another case[17] in which these changes were not demonstrated includes other strong evidence to support its final diagnosis of primary malignant melanoma of the esophagus. The case presented here complies with Allen's criterion of the primary origin of the tumor from the stratified squamous epithelium of the esophagus and is therefore regarded as the seventh reported case of this rare tumor.

SUMMARY

A case of primary malignant melanoma of the esophagus which complies with current criteria for this diagnosis is presented. It appears to be the seventh reported case. The patient experienced no dysphagia during the survivial period of eight months following resection of the tumor. Substernal and interscapular pain were considerably relieved after operation. Death occurred after a short period of rapid deterioration. Autopsy disclosed widespread involvement of the mediastinal and the supraclavicular nodes and multiple metastatic lesions involving the right frontal lobe of the brain. These latter lesions were thought to explain the euphoria which was present during the last surviving months.

A résumé of 14 previously reported cases of malignant melanoma of the esophagus is presented. Only 6 of those are currently considered primary in the esophagus. A summary of the current concepts of the pathology of tumors of this type is offered.

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Book Reviews

CONDUCTED BY J. GARROTT ALLEN, M.D.

Calderwood's Orthopedic Nursing. Revised by Carroll B. Larson and Marjorie Gould. Ed. 4. Boston, 1957, Little, Brown & Company. $9.00.

This latest edition of *Calderwood's Orthopedic Nursing* has been revised by Carroll B. Larson, Professor of Orthopedic Surgery and Chairman of the Department of Orthopedic Surgery at the State University of Iowa, and by Marjorie Gould, Supervisor of Orthopedic Nursing at the State University of Iowa. This book brings together specialized nursing techniques developed to meet the needs of individual problems in orthopedic surgery. The need for a book of this type is clear because probably nowhere else in medicine is alert conscientious nursing as important as in orthopedics. The scope of this book is ambitious, but the over-all quality is good.

There is an introductory chapter on the general problems of posture, especially as applied to the chronically bedridden patient to the end that joint deformities be prevented. A section on rehabilitation introduces some of the myriad of tools, techniques, and talents available to facilitate the recovery of the handicapped patient. There is an excellent chapter on particular problems created by the use of plaster dressings. This is followed by consideration of traction apparatus, its general application, and the nursing problems created thereby. There is a detailed account of crutch walking, with diagrams of gait patterns, use of crutches on stairs, and measurement of crutches.

The last two-thirds of the book is devoted to specific problems dealt with by the orthopedic surgeon. There is a brief discussion of the etiology, pathology, course, and treatment of each problem and an elaboration on the nursing care of the patient as it is complicated by the treatment in each case. Unit headings in this section of the book are congenital deformities, developmental diseases of bone, infections of bones and joints, metabolic disorders of bone, arthritis, poliomyelitis, cerebral palsy, common painful affections in adults, fractures and dislocations, bone tumors, and neuromuscular affections. The discussions of the disease processes are kept brief and to the point and should be stimulating to conscientious nurses who are interested in their patient more than superficially. In order to remain concise and within student understanding, simplification of the problems and their management has been inevitable. As the original author stated, the variation in techniques throughout the country makes it necessary to lay down broad principles on which the student can build with intelligent understanding. With this in mind, the book best serves to supplement the instruction which the nurse new to orthopedics receives from her attending staff and nursing supervisors.

—Wayne H. Akeson

Halsted of Johns Hopkins: The Man and His Men. Samuel James Crowe. Springfield, Ill., 1957, Charles C Thomas. $5.00.

Dr. Samuel J. Crowe, upon retirement after serving for 40 years as Surgeon-in-Charge of Otolaryngology at The Johns Hopkins Hospital, was persuaded by Dr. Alfred Blalock and other members of the surgery staff to write a history of the Department of Surgery

from its inception. Dr. Crowe was especially qualified to write this treatise because of his close friendship for so many years with Dr. William Stewart Halsted, the first professor of surgery, and many of the men whom Halsted trained.

Dr. Crowe does more than outline the history of the Department of Surgery; he begins the book with a background account of factors which motivated Mr. Hopkins, a man with only a country school education, to endow and enthusiastically support the development of a type of medical institution heretofore unknown in this country. He relates the influence of Daniel Coit Gilman, first president, on the development of the University, and that of William H. Welch, the first permanent appointee to the medical faculty of the Hospital and School of Medicine. Early members of the faculty believed that a distinguished faculty, not costly buildings, attracted high-caliber students. The unhurriedness and deliberateness which characterized the decisions and policies of the Board of Trustees pertaining to the development of the institution was evidenced by the fact that, although Mr. Hopkins died in 1873, it was not until 1889 that the hospital was opened.

Halsted's life from his college days is reviewed. His primary interest during his days at Yale was athletics and his scholastic record there was only average in contrast to his brilliant record at the College of Physicians and Surgeons in New York where he led his class. Following a competitive examination, he received an internship at the newly erected New York Hospital. This launched his career in surgery which was characterized by an apparently inexhaustible energy spent in a scholarly pursuit of knowledge and a consuming interest and curiosity in new ideas. He was one of the early New York surgeons who first employed Listerian principles of surgery. Acting as the donor, he administered what was probably one of the first direct blood transfusions in this country at a time when little was known about blood incompatibility. He performed on his mother one of the first cholecystostomies done in this country. In the treatment of fractures, he was one of the first, if not the first, to use bone plating with buried screws. His investigation of the effect of cocaine as a nerve blocking agent was a monumental contribution. The author points out that Halsted's appointment in 1889 as Surgeon-in-Chief of the Dispensary and Acting Surgeon of the Hospital for a probationary period of one year was designed to insure that his cocaine addiction had been overcome. His colleagues were apparently convinced of the permanency of this cure because in 1890, he was appointed Associate Professor and Surgeon-in-Chief of the Hospital and Dispensary, and in 1892, he was made full Professor.

Halsted's early days in Baltimore were spent for the most part in the experimental laboratory. It was during this period that he discovered that traumatized tissue enhances infection, that wounds with good blood supply are usually healed regardless of asepsis, that incisions should be closed gently in layers, and that drainage is essential when necrotic tissue or infection are present in the wound. This and his many other experiments clearly demonstrate the advantage of taking problems encountered in clinical practice to the laboratory for resolution.

Upon arriving at Johns Hopkins, he began to gather about him young men who were later to become leaders in American surgery. One of the first was John M. T. Finney; then followed others including Bloodgood, Cushing, Hugh Young, Mitchell, and many others. In selecting men who were to complete the residency training program, he often gave no indication of his interest in the individual until after he had worked with him for a considerable period of time. On the other hand, his interview with Finney consisted of formal inconsequential conversation and lasted only 2 or 3 minutes.

Halsted inspired a loyalty that influenced those associated with him to work on problems or in fields of his choice without marked persuasion or prodding. Suggestions from Halsted induced Cushing to enter neurologic surgery and Young to establish the first urologic department when both had previously had little or no experience in these fields. An outstanding example of this kind was the author's experience. Dr. Crowe had decided to accept an appointment with Cushing at the Peter Bent Brigham Hospital in neurosurgery. Shortly before he was to leave, however, Dr. Halsted suggested that he establish

a surgical division in the combined fields of otology and laryngology. Although Dr. Crowe had previously had no experience or interest along these lines, he nevertheless remained at Johns Hopkins to pioneer this field.

A chapter is devoted to the development of several of Halsted's outstanding residents and close associates. These include Harvey Cushing, Walter Dandy—the great neurosurgeon at Johns Hopkins, James Mitchell, Hugh Young, William Stevens Baer, Frederick Henry Baetjer, and Samuel James Crowe. A brief and interesting biography of each man is given and his relationship to Halsted is discussed as are his contributions to the institution and to his field. The author's close acquaintance with these men is evident throughout, and personal anecdotes and experiences make the book extremely interesting and entertaining reading.

The last chapters deal with Halsted's work on thyroid and parathyroid studies, experiments on intestinal suture, aneurysm and vascular surgery, and surgery of the bile passages. These were only a few of the problems in which Dr. Halsted was extremely interested and upon which he spent so much time in the experimental laboratory.

The author's final message leaves with the reader the realization that perhaps Dr. Halsted's greatest contributions to American surgery was a scientific approach to the investigation of surgical problems and the School of Surgery which he pioneered.

This book is beautifully written, is fascinating reading, and should be of great interest not only to surgeons but to physicians in many other fields and especially to those with a particular interest in medical history.

—William H. Muller, Jr.

Stress and Strain in Bones. F. Gaynar Evans. Springfield, Ill., 1957, Charles C Thomas. $6.50.

This book presents an excellent historical summary of experimental work on stress and strain in bones. Dr. Evans introduces his own experimental work in this field, and especially is this notable in the chapters on "Bone Healing and Growth," "Factors Influencing the Breaking Strength of Bones," and "Torsion, Bending and Fatigue Strength of Bone."

This book is of unusual interest to any individual concerned with the mechanical engineering aspects of bone.

—Crawford J. Campbell

Martius' Operative Gynecology. Edited by McCall and Bolton. Ed. 7. Boston, 1957, Little, Brown & Company. $20.00.

The current translation of the seventh edition of *Martius' Operative Gynecology* by McCall and Bolton constitutes the second English edition of this outstanding book.

Inasmuch as the first English edition was published 18 years ago, this current edition has been long overdue. The excellence of the translation does full justice to this classic work, and the editors' annotations which are included for the purpose of clarifying the difference between the American and German approach to gynecologic problems enhance its value.

It is difficult to avoid the use of superlatives in discussing Professor Martius' work. It is concise, authoritative, stimulating, thorough, and practical. It is devoted exclusively to operative technique and surgical anatomy. The topographic anatomy pertinent to the specific operative procedure is described and the surgical technique is outlined. Each operative step is thoroughly discussed and illustrated in detail. The number and quality of these illustrations, most of which are in color, constitute an outstanding feature of this work. The field of gynecologic surgery is systematically covered and chapters dealing with hernia repair and those aspects of urologic and abdominal surgery which are of practical importance to the gynecologist are included.

The current German edition upon which this translation is based differs chiefly from the previous editions in that the chapters on sterility and urinary incontinence have been revised to include the advances which have been made in these fields of gynecologic surgery.

Drs. McCall and Bolton have performed a significant service in making an English edition of this outstanding manual of gynecologic surgery again available to the American medical profession.

—Charles P. McCartney

Handbuch der Orthopadie. G. Hohmann, M. Hackenbroch, and K. Lindemann. Band I. Allgemeine Orthopadie. Stuttgart, Germany, Georg Thieme, Verlag. $42.40.

This *Handbuch der Orthopadie* will, upon completion, consist of four volumes and will contain an exhaustive survey of our present knowledge regarding the diagnosis and management of diseases of the musculoskeletal apparatus. It is primarily a reference work. Its chief importance to American surgeons is the careful evaluation and review of the ideas and experience of surgeons on continental Europe during the last 20 years, a period of time during which the periodical literature from this area has reached this country irregularly and incompletely. In a real sense, a publication of this scope brings us up to date and fills many gaps.

As might be expected, the material is well organized, thoroughly documented, and attractively presented. This Handbuch may well represent the most important single publication in the field of orthopedics in this decade.

—Leonard F. Peltier

Modern Operative Surgery. Edited by G. Grey Turner and Lambert Charles Rogers. Ed. 4. New York, Paul B. Hoeber, Inc. Vol. I, 1956, $15.00. Vol. II, 1957, $17.50.

This is a most ambitious work covering the full gamut of general and specialized surgery, including orthopedic, neuro-, thoracic-, otolaryngology, eye, head and neck and plastic, gynecologic, and urologic surgery. The work is the combined effort of 38 British surgeons. The book deals only with the operative and technical aspects of surgery, and the authors are recognized English authorities. Several chapters may be singled out for comment, notably the section on amputations by Sir Gordon Gordon-Taylor. This section reveals a wealth of practical experience rarely to be equalled and includes detailed descriptions of the interscapulothoracic amputation and the hindquarter amputation which the author has done so much to develop. In my opinion, this is one of the outstanding chapters in the two volumes. The section on operations on peripheral nerves by Sir Harry Platt is well documented and informative, and similarly the section on operations on the stomach and duodenum by Norman C. Tanner reflects a tremendous experience in this area. The neurosurgical sections by Geoffrey Jefferson are sufficiently detailed to be of aid to the general surgeon faced with a neurosurgical problem. Naunton Morgan's section on the rectum and the anal canal reflects the unequalled experience of St. Mark's Hospital, London, in this field.

While the remaining chapters appear adequate, they are not sufficiently detailed or informative to be of great aid to the general surgeon. Certain sections are particularly noteworthy in this regard; for example, the surgical treatment of esophageal varices is sketchily handled and operations on blood vessels are largely taken up with a description of vascular ligations, a subject which appears to be rather outmoded. Similarly, the wiring of aneurysms is given a disproportionate amount of space. Also the section on surgery of the heart and great vessels must be considered largely outdated. On the other hand, an area not often well covered in American surgical textbooks, namely, the detailed irradiation of mouth and tongue lesions, is most adequately handled in a section by A. J. Gardhan, and the importance of the spatial arrangement of radium needles is stressed.

Like many works attempting to cover so large a field, the standard varies considerably from chapter to chapter. Formerly, the breadth of practice of the general surgeon covered a tremendous range. This cannot be said to be true of the present time. Indeed, it must be the exceptional surgeon whose interests range from hemipelvectomy on the one hand to iridectomy on the other. It is my feeling that the requirements of present-day surgeons are better served by more detailed monographs on specialized subjects than by attempts, however well-planned, to embrace the whole field of surgery.

—Alan P. Thal

Injuries of the Hand. Ronald Furlong. Boston, 1957, Little, Brown and Company. Pp. 215. $9.00.

The outer jacket of this small book promises that it will be short, concise, and without burdensome detail. This is one instance where the jacket preface holds to fact. The author writes in a terse manner, keeping close to the point, at the same time managing to avoid the too frequent monotony of style and expression common in scientific writing. Another stimulating feature of the book is the strong stand of the author against some orthodox concepts and methods of management. Whether the reader agrees or not, he will inevitably be stirred out of the dull complacency which accompanies uniform, routine teaching. Dr. Furlong properly emphasizes the individuality of all cases and lays stress on the importance of the point of view of the patient.

The over-all organization of the book is good. It is copiously cross-referenced and the index is adequate. The book is replete with photographs of hand injuries.

The book is deliberately limited in scope, but is useful as an adjunct to other texts in the field, especially as an introduction to hand surgery and as a source for quick reference. In the words of the author, "The purpose of the book is to help the recently initiated surgeon who already knows the principles of surgery, but who has not had much experience in hand surgery. It is a kind of instruction manual to be referred to when the need arises. It is essentially practical in outlook and ambitious campaigns of reconstruction are not included."

One of the final chapters of the book considers problems of common fractures of the hand.

Within the limits which the author set for himself, the book is a useful one of high quality.

—Wayne H. Akeson

Manual for Ileostomy Patients. Ed 3. Revised by QT Inc., Boston, 1955. Pp. 53, 7 ills. $1.00.

This is a manual prepared for patients who have ileostomies. It is worthy of review for a surgical journal primarily because of the rather large and assorted types of information derived from the experience of many patients. There is no one type of ileostomy nor particular ileostomy appliance which satisfies all needs. The information assembled by QT Inc. in Part II of this manual should be extremely helpful to patients and to the doctors managing them. Nowhere can more precise experience with ileostomy care be found than is found in this manual. The subjects included are those relating to the appliance bag itself, how to change the appliance, maintaining personal hygiene, the use of belts, cement and adhesive materials, diet, dilating of the ileostomy by the patient, the care of the skin, and a list of the types of ileostomy appliances, the costs, and where they may be obtained. It should be useful to doctors and patients alike.

—Editor

Muscle Relaxants in Anesthesiology. Francis F. Foldes. Springfield, Ill., 1957, Charles C Thomas, publisher. 210 pp. $5.50.

Muscle relaxants have largely supplanted other drugs for the attainment of relaxation in general anesthesia. The very rapid development of neuromuscular blocking agents and their early widespread use has led to their inevitable misuse with the result that they have been damned on the one hand and praised to the skies on the other. As so often happens, extensive clinical usage has frequently preceded adequate clinical trials and the publication of the results. Not since McIntyre's work of 1947 has a monograph on the usage of relaxants been published. Since that time there has been extensive work on the curares themselves and the development of the whole new area of depolarizing agents. The need for a definitive work in the field of relaxants is obvious and this present monograph by Dr. Foldes fills this need.

The scope of this book is confined to a discussion of the safe and efficient administration of muscle relaxants. This is the defined purpose and the author accomplishes his task well. There are some interesting and helpful sidelights, however, which relieve what might be otherwise a mundane "cookbook" recitation. There is a short history of curare which might have been expanded a bit more, since the discovery and development of curare is one of the most dramatic episodes in the field of anesthesiology. A short, concise, and very understandable section on the physiology and pharmacology of neuromuscular transmission and blockade is well written, although somewhat oversimplified.

The second section, entitled "Clinical Use," runs through the entire gamut of the muscle relaxants. The methods of using the common agents are covered thoroughly. Such things as dose schedules, with various combinations of anesthetics, are suggested in a very schematic way and the use of antagonists is taken up briefly. There are also chapters on the complications resulting from the use of relaxants, on miscellaneous uses outside the usual field of anesthesiology, and on the variations in sensitivity produced by disease and age.

This is a very helpful and thought-provoking book. The only serious criticism is that succinylcholine and the various techniques built around this drug are apparently favorites of the author and his bias in this direction is obvious. This is certainly understandable for anyone who has worked in the field of the depolarizing agents as much as he. However, this bias tends to make the depolarizing techniques sound simpler and less liable to complication than they actually are. Be that as it may, this book is a real contribution and ought to be required reading for all anesthetists.

—Donald W. Benson

You and Your Operation. Benjamin R. Reiter. New York, 1957, The Macmillan Co. Pp. 150, 6 ills. $3.50.

This is a small and very readable book written for patients about to undergo a surgical operation. The story is well told and all aspects of the hospital stay and convalescence are fairly presented. There is no special philosophy or doctrine of practice pursued; only well-accepted routine hospital procedures, anesthetics, and surgical principles are presented. Most of these are arranged in the order in which the patient encounters them. The necessity of the "repeat" history by the intern, special studies such as blood chemistries, x-rays, basal metabolism, and the like are clearly described, and their values are presented honestly and fairly in a manner which should be most reassuring to the patient. A chapter about cancer and its implications and another about specific and common operations are especially well done. He is warned about the generous and often erroneous advice of his well-meaning lay friends and relatives.

An interesting and accurate chapter on the history of surgery affords the background for that which follows. Subjects such as how to select a surgeon or how to evaluate the surgeon recommended are discussed to advantage. The patient is wisely advised that should he

lack confidence in the surgeon it is better for the patient and the surgeon alike that another be chosen for his care. The central theme of confidence and the importance of the patient's acceptance of his surgeon's decisions are carefully explained.

The book is public and doctor-patient relations at their best. To this end, every surgeon, young or old, will find his time well spent reading this pleasant and factual exposé of what the patient can and usually does experience. It will also be useful to nurses and many of those in ancillary surgical facilities, for despite one's prior knowledge, this little book is refreshing and will assist even the experienced in an orderly means for discussions and answers to patients' questions.

Ethics are discussed, but fees are not. The author is to be commended for his clear, concise, and factual presentation.

—Editor

Student's Handbook of Surgical Operations. Sir Frederick Treves and Sir Cecil Wakeley. Revised by Sir Cecil Wakeley. Ed. 10. New York, 1957, Paul B. Hoeber, Inc. $7.50.

This latest edition of Sir Frederick Treves' *Student's Handbook of Surgical Operations* contains much new material in the sections on thoracic surgery, hernia, rectal surgery, and urology. The other chapters have been brought up to date by minor revisions.

The handbook-sized volume presents, in a style distinguished by its brevity and clarity, the anatomic bases and technical descriptions of most of the common operations in general surgery, orthopedics, and thoracic surgery. Less complete coverage of urologic, neurosurgical, and plastic procedures is included. Many of the operative descriptions are preceded by a list of useful instruments and the indications for performance of the particular procedures. The volume is well illustrated with line drawings which are well correlated with the textual material. Certain eponyms and special instruments described in this book are not in common usage in this country, but, for the most part this detracts little from the presentation.

The chapters on blood vessels, amputations, and orthopedic operations are outstanding in their presentation of surgical anatomic considerations for the various operations. However, the section on blood vessels, comprising fully 15 per cent of the book, contains only brief mention of the newer techniques utilizing homografts and prostheses. The sections on the extremities, abdomen, hernia, and breast are well presented and adequate in scope and detail. The sections on neurosurgery, thoracic surgery, radium, and skin grafting are so brief that their usefulness is limited.

Most textbooks of surgery contain little or no information on technique. The standard treatises on surgical technique are too specialized or lengthy to be of much value to the medical student. This volume bridges the gap between the two, presenting the technical aspect of surgical practice in a clear and easily understood fashion, and is recommended to those students desiring an introduction to surgical procedures. It is rather too brief for the resident working toward board certification in surgery or its specialties.

—Thomas S. Nelsen

Calendar of Surgical Meetings

AMERICAN ACADEMY OF NEUROLOGICAL SURGERY. *Annual Meeting,* Nov. 11-13, 1957, The Cloister, Sea Island, Ga. Deadline for papers, Aug. 15, 1957. Secretary, Dr. Eben Alexander, Jr., Bowman Gray School of Medicine, Winston-Salem, N. C. Attendance at meetings by invitation only.

AMERICAN ASSOCIATION FOR THE SURGERY OF TRAUMA. *Annual Meeting,* Oct. 31, Nov. 1 and 2, 1957, The Homestead, Hot Springs, Va. Deadline for papers, Aug. 1, 1957. Secretary, James K. Stack, 700 N. Michigan Ave., Chicago 11, Ill.

AMERICAN CANCER SOCIETY. *Annual Meeting,* Oct. 28-29, 1957, Park-Sheraton Hotel, New York City, N. Y. Participation by invitation only.

AMERICAN COLLEGE OF SURGEONS. *Clinical Congress,* Oct. 14-18, 1957, Convention Hall, Atlantic City, N. J. Secretary of the College, Michael L. Mason, 154 E. Erie St., Chicago 11, Ill.

AMERICAN MEDICAL ASSOCIATION. *Clinical Meeting,* Dec. 3-6, 1957, Auditorium, Philadelphia, Pa. Deadline for papers, July 15, 1957. Secretary, American Medical Association, George F. Lull, M.D.; Secretary, Council on Scientific Assembly, Thomas G. Hull, M.D.; address of both, 535 North Dearborn Street, Chicago 10, Ill.

THE INTERNATIONAL SOCIETY OF ANGIOLOGY. *Third International Congress,* Oct. 18-21, 1957, Ambassador Hotel, Atlantic City, N. J. Secretary-General, Henry Haimovici, M.D., 105 East 90th St., New York 28, N. Y.

INTERNATIONAL SOCIETY OF SURGERY. *Seventeenth Congress,* Oct. 20-27, 1957, City University Medical School, Mexico City. Details of hotel accommodations and reservations are being handled by "Mexamericana," Paseo de la Reforma 44, Mexico, I. D. F.

NEW ENGLAND SURGICAL SOCIETY. *Annual Meeting,* Oct. 4 and 5, 1957, Mount Washington Hotel, Burton Woods, N. H. Deadline for papers, June 1, 1957. Secretary, Richard Warren, M.D., Peter Bent Brigham Hospital, 721 Huntington Avenue, Boston 15, Mass.

PAN-PACIFIC SURGICAL ASSOCIATION. *Seventh Congress,* Nov. 14-22, 1957. Honolulu, Hawaii. Director General, F. J. Pinkerton, M.D., Room 230, Young Building, Honolulu, Hawaii.

SOUTHERN SURGICAL ASSOCIATION. *Annual Meeting,* Dec. 10-12, 1957, Greenbrier Hotel, White Sulphur Springs, W. Va. Secretary, George G. Finney, M.D., 2947 St. Paul St., Baltimore 18, Md. Guests are invited by the Secretary at the request of the Membership.

WESTERN SURGICAL ASSOCIATION. *Annual Meeting,* November 21-23, 1957, Hotel Utah, Salt Lake City, Utah. Deadline for submission of papers, Aug. 15, 1957. Secretary, John T. Reynolds, M.D., 612 N. Michigan Ave., Chicago 11, Ill.

AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS. *Annual Meeting,* April 23-25, 1958, Edgewater Gulf Hotel, Edgewater Park, Miss. Secretary-Treasurer, Dr. Wm. J. Engel, 2020 East 93rd Street, Cleveland, Ohio.

THE AMERICAN ASSOCIATION FOR THORACIC SURGERY. *Annual Meeting,* May 16-18, 1958, Statler Hotel, Boston, Mass. Secretary, Dr. H. T. Langston, 1919 West Taylor Street, Chicago 12, Ill.

AMERICAN GYNECOLOGICAL SOCIETY. *Annual Meeting,* May 19-21, 1958, The Grove Park, Asheville, N. C. Secretary, Dr. Andrew A. Marchetti, Georgetown University Hospital, Washington 7, D. C.

AMERICAN SURGICAL ASSOCIATION. *Annual Meeting,* April 16-18, 1958, Waldorf-Astoria, New York, N. Y. Secretary, Dr. William A. Altemeier, Cincinnati General Hospital, Cincinnati, Ohio.

AMERICAN UROLOGICAL ASSOCIATION. *Annual Meeting,* April 28–May 1, 1958, Roosevelt Hotel, New Orleans, La. Deadline for submission of papers Dec. 1, 1957. Secretary, Dr. Samuel L. Raines, 188 South Bellevue Boulevard, Memphis 4, Tenn.

THE CENTRAL SURGICAL ASSOCIATION. *Annual Meeting,* Feb. 20-22, 1958, Columbus, Ohio. Deadline for submission of abstracts, Nov. 15, 1957. Secretary, Dr. Charles D. Branch, 1002 N. North Street, Peoria, Ill.

THE HARVEY CUSHING SOCIETY. *Annual Meeting,* April 21-23, 1958, The Mayflower, Washington, D. C. Secretary, Dr. David L. Reeves, 316 West Junipero Street, Santa Barbara, Calif.

INTERNATIONAL UNION AGAINST CANCER. *Seventh International Cancer Congress,* July 6-12, 1958, London, England. Papers, dealing with new and unpublished work, must be submitted with abstract (not over 200 words) before October, 1957. Secretary General, Harold Dorn, National Institute of Health, Bethesda 14, Md.

NEW ENGLAND SURGICAL SOCIETY. *Annual Meeting,* Oct. 3 and 4, 1958, Mount Washington Hotel, Burton Woods, N. H. Deadline for submission of papers, June 1, 1958. Secretary, Dr. Richard Warren, Peter Bent Brigham Hospital, 721 Huntington Avenue, Boston 15, Mass.

PACIFIC COAST SURGICAL ASSOCIATION. *Annual Meeting,* Feb. 3-5, 1958, Biltmore, Santa Barbara, Calif. Secretary, Dr. Carlton Mathewson, Stanford University Hospital, San Francisco, Calif.

SOCIETY OF UNIVERSITY SURGEONS. *Annual Meeting,* Feb. 13-15, 1958, Boston, Mass. Deadline for submission of abstracts three months prior to meeting. Secretary, Dr. James D. Hardy, University of Mississippi Medical Center, Jackson, Miss.